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Winter 1970

South Dakota Farm & Home Research

Agricultural Experiment Station, South Dakota State University

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An advance fashion note?
See page 23

Vol. XXI Winter 1970 No. 1

South Dakota Farm & Home Research

Agricultural Experiment Station • South Dakota State University

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contents . . .

FRONT COVER — With the world becoming noisier all the time, what if it becomes necessary to wear acoustical earmuffs to protect hearing and health? Earmuff engineers and fashion designers should have a field day combining bright colors, sequins, and other do-dads, even dreaming up sports-models, dress-models, and his-and-her models.

Although pretty Janelle Welch is not about to drive a tractor, she checks the appearance of an ordinary lightweight noise-reducing earmuff of the type SDSU students will be showing to South Dakota farmers interested in reducing harmful effects of noisy agricultural machinery. Janelle, a journalism junior at SDSU, is the daughter of Mr. and Mrs. Robert G. Welch, Watertown.

From the Dean and Director . . .

An Investment, a Challenge, a Compliment, a Responsibility

Duane Acker

South Dakota, through its Regents of Education, Governor, and Legislature, has just decided to make a higher investment in agriculture, the State's number one business. The general appropriation bill signed by the Governor following adjournment of the Legislature February 14 provided a 5% inflation increase in State funds for the Agricultural Experiment Station and for the Cooperative Extension Service, plus $35,000 for "senior scientist support teams" in the Agricultural Experiment Station and $48,500 for new extension specialists in the Cooperative Extension Service. The Legislature also appropriated $200,000 to help construct the first phase of a new Plant Science Research Facility on the SDSU campus.

South Dakota agriculture has a great growth potential, and the Agricultural Experiment Station and the Cooperative Extension Service have a responsibility to help achieve this potential. The investment decisions made by the State will aid these two agencies in doing their jobs.

We recognize this increased investment by the State is a compliment to our staff for the good work they have done in years past. At the same time, it is a challenge to both research and extension workers to rededicate themselves to the growth potential of South Dakota agriculture and the needs of the State.

The senior scientist support teams will be the first new program funded for the Agricultural Experiment Station by the South Dakota Legislature since the operations of the Southeast Experiment Farm near Centerville were financed in 1961. The $35,000 will be used to speed up research activity in high-priority projects where there are high chances of payoff for the State's agricultural economy. Historically, this experiment station has had relatively few support workers for each senior scientist. Hence, senior scientists have sometimes devoted their time to washing glassware, planting seeds, laboratory analyses, etc. Technicians, labor and graduate student help that these new funds will provide will permit us to make more effective use of our available scientists.

The new funds for the Cooperative Extension Service will provide a State Feedlot Nutritionist, an irrigation engineer, a potato inspector, and a wildlife specialist. The potato inspector position is not new; the appropriation of $6,000 for it merely represents a transfer of funds from a different agency to the Extension Service. Half of the funds for the wildlife specialist will be provided by the State Department of Game, Fish and Parks.

The plant science facility had been sought by farmers and seed producers for several years, and last August the South Dakota Wheat Commission pledged $100,000 to such construction, provided the Legislature would appropriate $200,000. It is expected that construction will begin in late summer or early fall.

You often hear a figure of as much as $10 in returns for every $1 spent in agricultural research, although any exact figure is hard to come by. While this investment has turned out to be excellent dollar-wise, we must also keep in mind that we are after an additional "something" for which no assignment of dollar value can be made. This is an improvement in living, betterment of our surroundings, deeper understandings — a way of life in which we and our environment are totally compatible.

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To simplify terminology, trade names of products or equipment are sometimes used. No endorsement of specific products or equipment named is intended, nor is criticism implied of those not mentioned.

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A Report of Progress

Vol. XXI Winter 1970 No.1

Duane Acker
Dean, College of Agriculture and Biological Sciences, and Director, Agricultural Experiment Station

Frank J. Shideler
Editor (Editorial Office, South Dakota State University, Brookings, S. Dak. 57006

Vol. XXI Winter 1970 No. 1

South Dakota Farm & Home Research

Agricultural Experiment Station • South Dakota State University

SERVING THE PEOPLE OF SOUTH DAKOTA THROUGH TEACHING, RESEARCH, EXTENSION

Tons of 'em . . .

Redfield Soil Samples to SDSU for Research

Maurice L. Horton, Agricultural Experiment Station soil physicist in charge of the project, checks out a surface temperature sensor which will be used in evaporation experiments. This instrument is similar to the ones used in aircraft for "thermal photography" in remote sensing.

Researchers have brought soil "samples" – upwards to 10 *tons* of them – from near Redfield 125 miles away to South Dakota State University campus to preview what irrigation will likely do to Spink-Brown county land once water begins flowing into the Oahe Irrigation Unit.

The six samples are quite special. Each is a 2,800-pound, 3-foot-diameter "core" of the top 5 feet of soil from the SDSU Agricultural Experiment Station research farm east of Redfield. It is Beotia silt loam still in its original, undisturbed state and is representative of thousands of acres of land to be included in the Oahe project.

Research results using these "samples" are expected to give farmers new information – a head start – so they'll have up-to-date knowledge to help in successful management of their land and water under irrigation farming. Dr. Walter Lembke, now with the University of Illinois, who previously conducted lysimeter research at Redfield, was responsible for obtaining the core samples.

Salt Accumulation

The research involves studies of water, soil, plant and climate relationships, according to Maurice L. Horton, soil physicist with the Plant Science Department at SDSU. Salts dissolved in the soil water are left behind at the surface when evaporation occurs. A major objective of this investigation will be to obtain information on the rate of salt accumulation under two levels of drainage. Another objective is to develop a system for predicting salt accumulation rates and to determine procedures for preventing or correcting the problem during irrigation.

Many ancient civilizations built on irrigation have vanished due to their inability to cope with the problem of salt build-up in the soil. Even now the lush Imperial Valley of California is threatened with salinity problems. Many vegetable and grain crops cannot tolerate salty soils and the production rapidly decreases below the level of economic return.

Research near Redfield by the Agricultural Experiment Station over the past several years has revealed that salt accumulation on the soil surface is closely related to the amount of water evaporating from the soil profile, Dr. Horton says. Evapotranspiration rates – evaporation from the soil surface and transpiration by plants – will be one of the basic factors in estimating salt accumulation rates.

Plant Growth Problems

Irrigation and development of a water table within a few feet of the soil surface introduces other plant growth problems in addition to accelerating the rate of salt accumulation, continues Dr. Horton. Plant roots require a supply of oxygen throughout the rooting zone which is concentrated in the top 3 feet of soil. Excessive water can restrict aeration and cause oxygen deficiencies. The SDSU soil physicist adds that a limited number of measurements of oxygen diffusion rates in irrigated fields on the Redfield farm have not shown serious oxygen shortages.

Percolation of water through the soil is a prime consideration in the research because this is one method of removing – or preventing – a salt build-up. From this and other data, such as aeration level, drainage requirements can also be determined. This is where dollars and cents enters the picture – the farther field drainage tile lines can be spaced apart, the lower the total cost.

Just how the researchers intend to get their information involves a major effort in itself and therein lies the story of the 2,800-pound soil "samples." To get them it was necessary to press open-ended cylinders of quarter-inch steel into the ground to obtain a 5-foot undisturbed section of soil. This was done with 30,0[illegible] pounds of surplus 3-inch armor plate as weight to sink the cylinders into the ground. Then the cylinders or "cores" were removed with a crane and hauled to Brookings.

Bank of Lysimeters

The cores were placed in the six holes of a specially-designed set-up near the campus that permits detailed measurement and control of water in the soil. Since precise water control was desired, excess water in the form of rain had to be prevented from entering the cylinders – which are called lysimeters, a commonly used research tool for percolation and drainage studies. The steel sides of the lysimeters prevent entrance of water laterally from the "Brookings soil," but to keep rain from entering at the top, six covers or roofs are mounted on a frame which moves along a horizontal track. A sensing device automatically causes a motor to pull the covers over the corresponding lysimeters after the first few drops of rain. After the rain stops, the sensor turns on the motor to pull the frame back and the lysimeters are uncovered.

Use This Summer

The bank of lysimeters will be ready for full operation in the summer of 1970. He explains that the system will be operated as "fallow" land originally to obtain data on maximum salt accumulation over 2- and 4-foot water table depths. Next a "crop" will be included to observe how it alters the evaporation and salt accumulation picture.

Horton cites several advantages of having undisturbed Redfield soil near the SDSU campus and laboratories. For one thing, it eliminates many 250-mile trips that researchers previously had to make to record data or observe the experiments. Also, it permits more sophisticated instrumentation to be used. The research is a cooperative effort involving the Plant Science Department, the Agricultural Engineering Department and the South Dakota Water Resources Institute.

The climate of Brookings and Redfield are near enough alike so that particular factor doesn't pose a problem. However, the water supply at Brookings is different from Missouri River water which is to be used on the Oahe Unit. This could cause a problem or might alter the experimental results. Solving this problem, however, was comparatively easy: all water used in the lysimeters is stored in 250-gallon fiberglass tanks which are filled two or three times during the summer growing season with water brought from the Missouri River.

A 36-inch diameter steel cylinder is sunk into the ground at the SDSU irrigation experiment farm east of Redfield to obtain an undisturbed "core" of soil for use in research. Weight of some 30,000 pounds of surplus 3-inch armor plate pushes the cylinders into the soil as shown. Note the cylinder at lower right which has already been pushed into the ground.

More photos next two pages

The six soil-filled cylinders are placed in holes in a special set-up near the SDSU campus at Brookings. Water level and salinity sensors plus water-supply and drainage pipes are within the cylinders (called lysimeters). These are connected through conduits buried in the surrounding trench. The large concrete cylinder (upper left) is a drain outlet and access manhole, used for removing tile drain water and for regulating lysimeter water level. Temporary covers were used over lysimeters in this photo of preliminary construction.

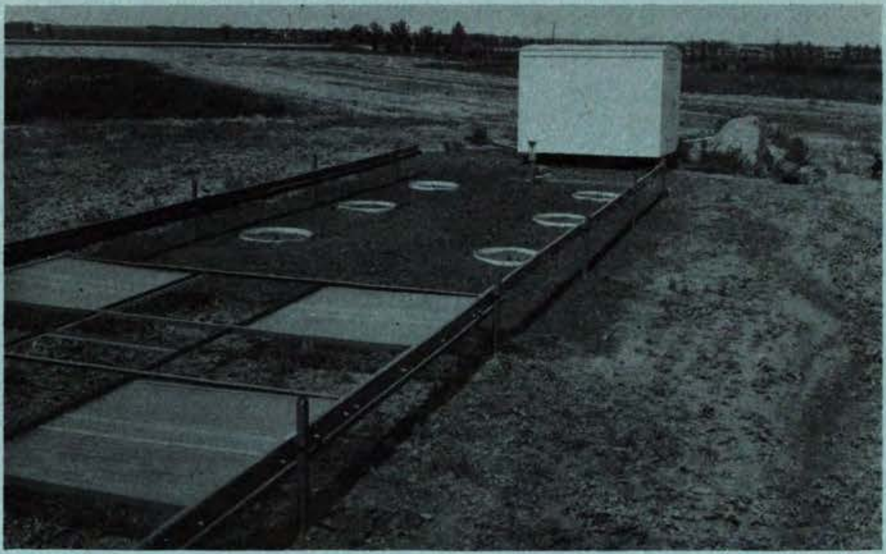
Inside the access manhole are ends of the six conduits which carry water to and from the lysimeters. The large hole above the conduits is a tile outlet to drain the area surrounding the lysimeters.

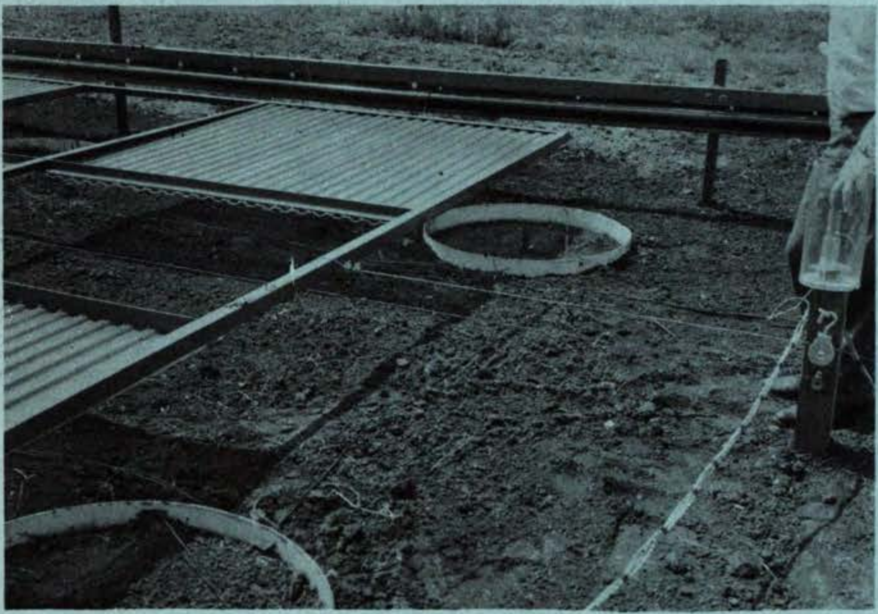
Pipes within the lysimeters are for measurement of soil water content. Excess water is drained through an outlet at the bottom.

Edwin A. Dowding, instructor in the SDSU Agricultural Engineering Department who assisted in installation of the lysimeter covers, demonstrates part of the rain sensoring device (beneath funnel) which triggers the small electric motor (lower right) that operates the rack carrying lysimeter covers.

This is a thermistor water level sensor, one of the devices within the lysimeter which triggers valves regulating water flow and water level control.

Overall view of bank of lysimeters with instrumentation housing (background), track for the automatic covering device (center diagonal), and three of the six corrugated fiberglass covers (lower left).





Covers being brought into position over two of the lysimeters (note shadows). Sensor device at right is here operated manually in simulated action.

Inside the instrumentation house terminals of sensoring equipment are connected with small water tanks and to a control device (not shown) that automatically senses change in water table depth and opens water supply valves. The tanks supply Missouri River water to automatically maintain water table at desired levels in various lysimeters. Each lysimeter requires about 26 gallons of water a month. This amount takes care of an equivalent of about 6 inches of evaporation during that time.

Greenbugs: A Yearlong Pest for Entomologists

John E. Kvenberg (left), graduate research assistant, and Dr. Philip A. Jones, survey entomologist with the Agricultural Experiment Station, inspect a "cage" housing greenbugs used in research. These greenbugs live in fall-like temperatures in the growth chamber (background).

Just because greenbugs didn't appear for a research showdown with scientists in South Dakota winter wheat last fall does not mean the sometimes-costly insects will get off entirely scot-free.

Although happily disappointed that greenbugs didn't repeat the heavy fall invasion of 1968, research entomologists at South Dakota State University don't think the battle is over by any means. "The 'no-show' of the insects last fall was good for the farmers and we are glad about that, but as far as extensive research in the field was concerned we were left somewhat empty handed," explains an entomologist from the Agricultural Experiment Station at SDSU.

Meanwhile, back in the laboratory, scientists are assembling more information about greenbugs (also known as aphids) which might be useful in future confrontations. For one thing, scientists are closely observing effects of weather on greenbug reproduction and longevity. This is done in the greenhouse and in special growth chambers where temperatures and humidity can be controlled. Wheat, sorghum and corn are used in these experiments.

Weather Factors

"In 1968, weather in the western South Dakota winter wheat areas was warmer and this probably was partly the reason for high, destructive populations of greenbugs," says Philip A. Jones, entomologist at the Agricultural Experiment Station. Last fall the winter wheat stooled out well, but was shorter than in 1968. It is surmised that the freezing effect of the early October snowfall in 1969 probably went all the way to the ground. This drastically affected the greenbugs because there was no protective blanket above the ground and over the greenbugs as in the first snowfalls of 1968. It may be assumed that the early snowfall coupled with an extended cool period in October and early November probably held the greenbugs below the level necessary for a progressive build-up as in 1968.

About 1,500 acres of winter wheat were treated with insecticides at planting time in the experiments last fall. But since the greenbugs didn't appear in force, it was impossible to check out the effectiveness of these treatments. However, the planting time applications served purposes other than just immediate control of greenbugs. Additional data was obtained on insecticide application methods and problems, and hopefully another pest of wheat might be controlled. The animal involved here was the leaf mite which transmits wheat streak mosaic. The leaf curl mite can be found in volunteer wheat and usually is most apt to occur in infestations in wheat planted in areas hailed out the previous season. Mites as well as the greenbugs move from volunteer wheat into winter wheat. It is hoped that the systemic insecticides applied at planting time and taken up by the wheat into the tissues would kill both greenbugs and mites. Some of the 1969 planting time applications were made in areas known to have been hailed out. However, mite mortality, as judged by a reduction in wheat streak mosaic, cannot be determined effectively until this spring.

Not "New" Insect

When greenbugs attacked South Dakota sorghum for the first time in 1968, there were suggestions that a new form of the insect might be present (sometimes as many as 5,000 of them on a single sorghum plant). So far, however, insect identification specialists in the United States and Great Britain say the 1968 attacks were by the same old aphid model. Technically the greenbugs are known by the scientific name, *Schizaphis graminum* (Rondani). But something evidently was different. To check into this, SDSU entomologists are also using growth chambers to raise greenbugs from field collections made last August. These aphids are being compared with a laboratory-reared strain collected in the field and maintained by the federal Northern Grain Insects Research Laboratory at Brookings. Entomologists hope that they'll be able to spot any differences in the insects themselves, or possible adaptation or other trends involving the new (sorghum) host plant.

Greenbug infestations on sorghum in 1969 were heavier and more widely distributed than in 1968. An estimated 120,000 acres of sorghum were infested with economic numbers of greenbugs, of which 50,000 acres were treated for greenbug control. Greenbug populations had expanded rapidly during the period of head development on the sorghum. A reduction in yield occurred on untreated acres.

Greenbug Parasites

Greenbugs have problems with parasites, such as a tiny wasp, and with predators, the ladybird beetle being one, according to Dr. Jones. Part of the growth chamber studies may be used to gain more knowledge of the greenbug-parasite-predator relationships. The duration of the predators' life cycle and population build-up are controlled by both weather and availability of host (the greenbug). If predators are present in sufficient numbers they will assist in reduction of greenbug populations, although Dr. Jones feels that artificial introduction of large numbers of the insect enemies would offer few if any advantages. "If the native predators are present naturally they build up – if not, conditions are probably such that introductions would not thrive either," he explains. "The greenbug is also now a fall insect problem for South Dakota which means the weather will often be too cold for the predators to provide natural control."

As the greenbug menace ranges throughout the plains regions, several states including South Dakota are cooperating in research. Some southern states have a regional project underway with main emphasis on greenbugs in sorghum. Later the work will be on small grains. In South Dakota, work emphasizes small grains first, then sorghum. Much of the South Dakota research is supported by a grant from the South Dakota Wheat Commission.

Kvenberg holds a capsule containing a parasite of greenbug. The parasite lives in the body of a dead greenbug and when it emerges as an adult will become part of a study on possible biological controls of the tiny aphid which causes damage to South Dakota wheat and sorghum.

A guide for communities . . .

Selling Municipal Utilities

By
Mark J. Powers, associate professor, and
Gene Schwab, former research assistant,
Department of Economics

The United States now has about 2,000 municipally-owned electric utility systems, 33 of them in South Dakota. Many communities are questioning the desirability of owning electric utilities as opposed to selling them to investor-owned utilities. Other communities are considering the establishment of their own municipal electric system as opposed to continued reliance on an investor-owned system.

A change in the ownership status of a municipal electric system raises important questions for townspeople as well as for farmers of the community. An example: One of the most important considerations in a change in ownership of a municipal utility system is the impact on taxes levied for support of the local school district. If a municipal utility does not make in-lieu-of-tax payments to the local school district, farmers and other property owners who live in the school district may find their tax levies higher than if the municipal utility were owned by an investor-owned utility that paid property taxes. If, on the other hand, the municipal utility makes in-lieu-of-tax payments equal to the property tax that would be paid by an investor-owned utility, then the townspeople who purchase electricity would be subsidizing farmers and agricultural property owners.

Wider Area Affected

Farmers and other rural residents may also be affected by a change in the ownership status of the electric system in a town if the change results in a change in the tax funds flowing into the country treasury. Thus, a change in the ownership of the electric system in a town is of concern not only to the townspeople who pay for the electricity but the entire group of taxpayers whose taxes support the local and county government units. This includes farmers and agricultural property owners.

Economic Aspects Considered

The question of whether or not a municipality should own its electric system frequently becomes involved with political and philosophical values. These aspects of the arguments in favor of, or opposed to, municipal ownership are not considered here. However, the economic aspects of a change in ownership are considered. This does not imply that these political and philosophical considerations are unimportant. They are important and must be considered in light of the economic factors. Thus, it is not the intent here to show that all or any municipalities should or should not own their electric systems. That decision must be left to the individual municipalities to consider in light of their values and their particular economic situation.

A city should weigh both the costs and the benefits to the governmental units and to its residents when considering sale of its electric system to an investor-owned utility. These costs and benefits may be explicit or implicit. The explicit costs would be the loss of revenues to the city government and the possible increased cost of electric service for the city government units. Implicit costs and benefits would include those costs and benefits that do not directly affect the city government but rather accrue to residents and electric consumers, i.e. changes in the electric rates or wage rates.

Economic Model

An economic model is a device to show relationships between variables and

This article briefly presents some of the data obtained in a study of ownership of municipal utilities conducted by the Economics Department of the Agricultural Experiment Station. Additional and more detailed information is contained in Agricultural Experiment Station Bulletin 564, "Economic Considerations Relating to the Sale of Municipal Utilities." This bulletin is available through county Extension offices or from the Bulletin Room, South Dakota State University.

their interactions with each other. In the case of an economic model of a municipal electric system, seven major variables may be identified. They are electric rates, taxation, finance, services, expansion, management, and employment. These variables are very much interrelated and a change in one usually affects other variables in the model.

Figure 1 delineates and illustrates variables and their major components. The diagram indicates the major relationships between variables and it displays the significant relationships between components of variables. It is not intended to be all inclusive of all possible interactions between variables, but it does indicate the major interactions between variables of a municipal electric system model.

While there are many possible orders in which the variables of this economic model may be examined, here we consider them in the following sequence: electricity rates, taxation, finance, services, expansion, management, and employment. These variables or factors are of great significance in the decision-making process of the community.

Electricity Rates

Rates for electricity are influenced by and have an influence on other variables such as finance, management, taxes and employment. Differences in rates charged for electricity between an investor-owned company and a municipality can be quite significant and should be considered by any city contemplating the sale of its electric system. Although rates charged by municipalities are often below the rates charged by investor-owned utilities, one should consider other things besides rates alone in the comparison of the ownership. For example, services may also be much better under the investor-owned systems. Too much emphasis can be given to rates alone.

To study the effect of rate changes, the cost of electricity to various groups of consumers under the different form of ownership should be investigated. This cost should be a yearly basis. One method of determining the amount of rate change is to use the monthly kilowatt hour consumption of each class of consumers and multiply that by that prospective rates of city-owned utilities as contrasted with the rates of investor-owned utilities that may be prospective buyers. Attention should also be given to the effect that a sale to an investor-owned company would have on the cost of power to the municipality for street lighting, city hall, water pumping stations.

Taxation

The amount of taxes collected has a direct bearing on city finances as this is the major source of revenue for most cities. A sale to an investor-owned company would add property to the tax rolls but the city would receive only a portion of the property tax payment by the utility, with the remainder going to school districts and county government. Under municipal ownership the various units of government may be compensated for the loss of tax revenue through the receipt of payments by the utility in lieu of taxes. Depending upon the size of these payments and their distribution to city, school district and county governments, the tax levies for farmers and other property owners may be higher or lower than they would be under investor ownership.

Finance

The finance variable and its components is influenced by many other variables in the model and it in turn exerts considerable influence on them. Of prime consideration under this variable is the disposition of profits under city ownership. Basically the city has three choices for disposing of the profits: (1) transfer them to other city funds, part or all of which may be in-lieu-of-taxes, (2) accumulate them in reserve for future expansion of the system, and (3) give rebates to the consumers. Choice of these methods is influenced considerably by the city officials' concept of the desired capital structure for their electric utility. If it is decided that the capital structure should be such that liabilities should be high relative to assets, there is no need for large reserves since expansion would probably be financed by sale of bonds and profits could be transferred to city funds or returned to customers. If the desired capital structure is such that liabilities should be low relative to assets, then it will be necessary to use profits for current capital investment and accumulation in a reserve fund for future expansion.

One major effect on municipal finances due to the sale of a municipal electric system is, of course, the loss of profits for both the present and the future or in the case where money is being lost with a municipal system, a sale would mean the end of a drain on the city treasury. A second major effect on municipal finances would stem from the manner in which the proceeds from the sale were used.

Service

Service is defined for this section as the supplying of the proper quality of electrical energy to consumers and the supplying of other services that would, in the absence of the utility, have to be supplied by others. Quality electrical energy service includes furnishing electricity to the consumer at the proper voltages and quantities with a minimum of outages. To provide quality service the distribution system must be maintained at about the same level under either type of ownership. If a municipality's maintenance is poor, resulting in poor quality service, it must take into account in its decision the cost of bringing its system up to the proper and sufficient level that would be maintained by an investor-owned system. Some municipalities also provide other services to the community that probably would not be continued under investor ownership. These services include steam heating of downtown buildings, equipment monitoring for the city, and erection of street decorations for the city. The costs and benefits of these changes should be evaluated and considered in monetary terms whenever possible.

Expansion

Expansion of the electric system may involve generation of additional power or construction of additional distribution facilities, or both. Expansion of the electric system of a community influences the variable of finance through the additional revenues derived from selling more electricity. The preparation for expansion depends in part on the availability of reserves of a bond issue to finance the program. The need for expansion may derive from increased population in the community or the desire for improvement of the distribution system.

A municpality that has decided to retain its electric system must make plans for obtaining additional power it expects to need in the future. The most usual sources of power are three: local generation in the municipal plant, power purchased from an investor-owned system, and power purchased from a large generating plant owned by a group of municipalities. Each of these sources needs to be evaluated from a cost-benefit standpoint. Also important is the expansion of local distribution facilities to maintain and possibly improve the quality of service. With increased consumption by each household, it is necessary to install large transformers and lines of greater capacity. The expansion of the distribution system is probably of less concern to city officials and residents as the acquisition of additional power sources. However the distribution system cannot be neglected without a detrimental effect upon the quality of electric service.

Management

Management includes the decision-making function relative to the other variables in the model. If a city sells its municipal electric system, the present management would probably be replaced with men transferred from other cities where the investor-owned utilities operates. The municipality would be relieved of its supervisory functions over the electric system, and this may enable the elected and appointed officials to devote more attention to other functions of the municipality.

If the municipality decides that it does not want to sell its electric system, it must concern itself with the management of the system. The success that the city achieves in the operation of the system depends to a large degree on the form of government and the availability and selection of competent men to manage it. Farmers and property owners outside the municipality proper have direct interest in the variable, since it is management that makes the decisions on in-lieu-of-tax payments, etc.

Employment

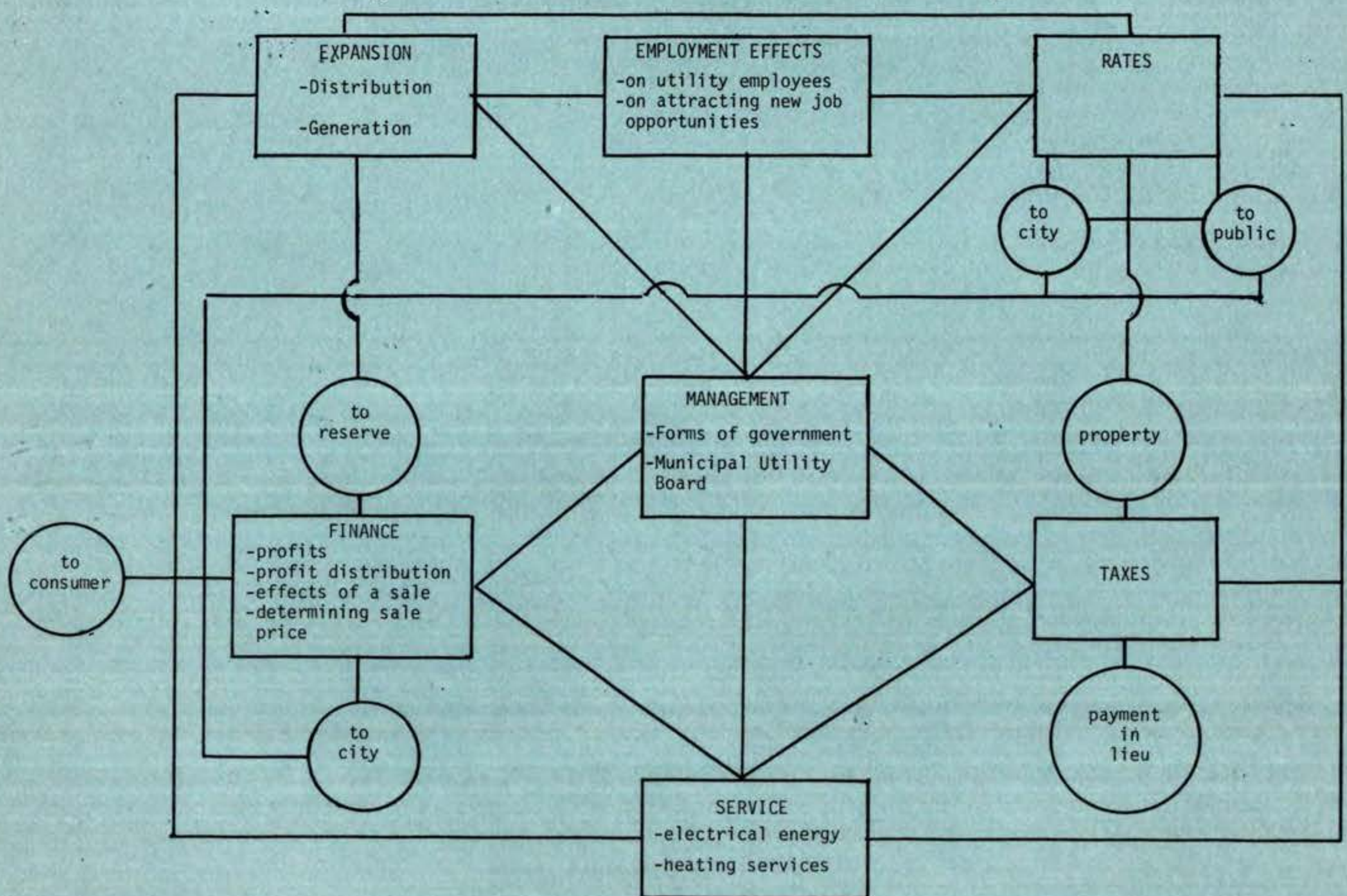
One effect of the sale of a municipal electric system to an investor-owned company may be a change in the number of workers employed in the community and their wages. The magnitude of the change in employment associated with a change in ownership depends on a number of things: First, whether or not the purchaser discontinues operation of the local generating system; second, whether or not the purchaser decides to establish a distinct office or an enlarged generating plant; and third, whether or not the purchaser establishes a retail store and service department for selling electrical appliances and for servicing the electrical system.

Generally, under private ownership the wages for employees are higher than under public ownership because employees of investor-owned companies are often unionized and bargain for higher salaries. Municipal employees, on the other hand, are usually prohibited by law from joining a union that claims the right to strike.

Selling a municipal electric system to an investor-owned utility is not likely to change employment in local businesses due to increased sales of materials and supplies to the electric utility. Total employment would, however, increase if the investor-owned utility were able to attract new industries to the community that the municipal utility could not attract. It is questionable, however, if the type of ownership of the utility exerts a great influence on industry location.

In summary, these factors outlined above must be considered by a community contemplating the sale of its municipal electric system. The impact of the changes in ownership on each of these factors and the impact each factor has on each other factor should be evaluated by the community. Farmers and other residents in the school district and county but outside the municipality should be most concerned with the management factor and the impact a change in ownership will have on their tax levies. Whenever possible the costs and benefits for the changes expected in each factor should be quantified and totaled for each alternative. The resultant figure should then be considered in light of the value placed on the non-quantifiable costs and benefits.

Figure 1 – The economic variables and their interrelationships.



Implications of

SOIL TEMPERATURES IN MAY

By
Paul Evenson, assistant professor of agronomy, and Tamlin Olson, research soil scientist (USDA) and associate professor of agronomy.

All agricultural production depends upon plant responses to environmental conditions. Soil temperature is one important environmental factor affecting these responses. This article briefly reviews the importance of soil temperature in agriculture and describes the characteristics and implications of soil temperatures in South Dakota. A procedure for measuring soil temperature is given at the end of the discussion.

Importance of Soil Temperature

An indication of the importance of soil temperature is the large number of articles published on this subject. Excellent discussions and bibliographies on the subject of soil temperatures, for example, have been published by Carson (1), Willis (2), Rose (3), and Hagan (4).

New recording and sensing equipment and the importance of soil temperature to agriculture have prompted scientists to explore this area extensively. However, the number of unanswered questions related to soil temperature continues to grow as cultural practices change. For example, narrow rows and minimum tillage alter the light, wind, humidity, air, and temperature distributions in and around the plant canopy, resulting in new plant-soil-temperature relationships. New and better cultural practices should evolve as our understanding of the plant-environment relationship increases through research.

South Dakota farmers are aware of the variations in weather from year to year and that crop responses vary with the weather; therefore, they can appreciate the great number of measurements and observations required to understand the problems posed by new cultural practices. Complete records of crop and environment could vastly improve our ability to predict crop responses to future weather conditions. At the present, the USDA Research Farm at Madison is the only station in South Dakota that regularly reports soil temperatures. Other soil temperature measurements have been recorded periodically at Redfield and Brookings. More soil temperature recording stations are urgently needed throughout the state.

Influences of Temperature

Soil temperature influences almost all chemical, physical and biological processes associated with crop growth. Chemical reaction rates in unfrozen soil approximately double for every 18° (F) rise in soil temperature. The availability of essential elements for plant growth and the movement of water, gas and ions in the soil increase as the temperature increases. Soil temperature greatly modifies air temperature immediately above the soil surface, and also the rate at which water evaporates from moist soils. Soil temperature also influences the amount of growth regulators that are produced in plant roots; therefore, cultural practices such as narrow-row spacings, high plant populations, stubble mulching, and minimum tillage, which modify soil temperature, can alter plant growth in many ways.

Soil microorganisms grow best at about 95° but the optimal temperature varies from one organism to another. Therefore, the soil microorganism predominate at any given time is determined, to some extent, by soil temperatures.

Temperatures Vary Widely

Seed germination and seedling emergence also are influenced by soil temperatures although the optimum temperature varies widely from one plant species to another. For example, corn requires an average minimum soil temperature of about 55° for proper germination, whereas the minimum for sorghum is 65° to 70°. That is one reason soil temperature is a factor in determining the planting date of crops and in breeding and selecting crops to be grown under a specific set of conditions.

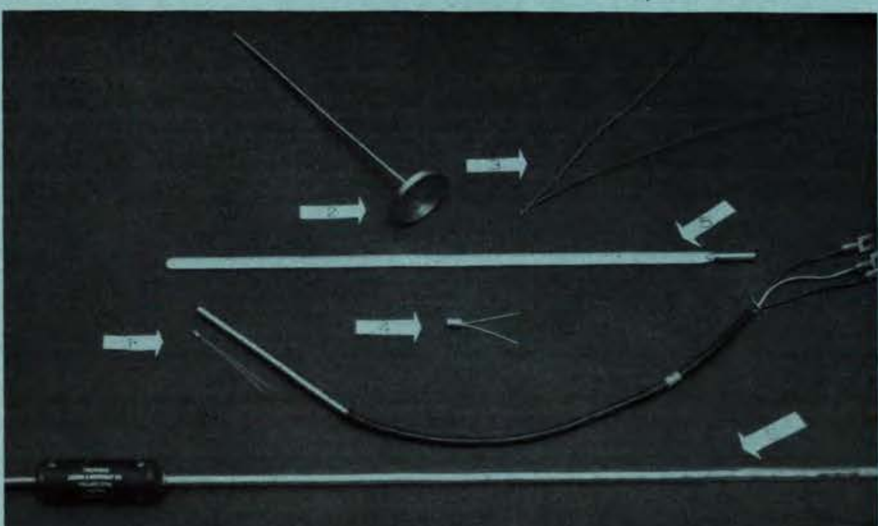
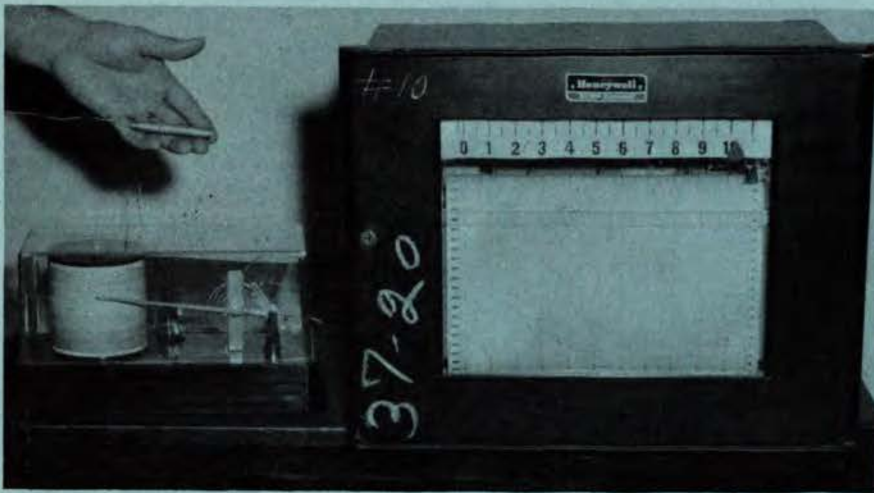


Figure 1. Several types of temperature measuring devices. They are (1) thermistor and thermistor probe, (2) bimetal thermometer with dial, (3) thermocouple, (4) diode, (5) mercury-in-glass thermometer, and (6) platinum resistance thermometer. A farmer making temperature measurements would probably use (2) and (5).

This article on soil temperatures is a contribution from the South Dakota Agricultural Experiment Station in cooperation with the Corn Belt Branch, Soil and Water Conservation Research Division, Agricultural Research Service, USDA.

Recognition is given to LaVern S. Schoelberl, agricultural research technician; Peter E. Stegenga, engineering technician; and Donald K. Warren, agricultural research technician, ARS., USDA, Madison, for their assistance in conducting soil temperature measurements.



Measurements of soil temperature as an aid for determining planting dates may be made by digging a small trench in the soil and inserting a thermometer horizontally into the side of the trench at seed depth. The temperature should be measured at about 7:00 a.m. or 6:00 p.m. to arrive at the average temperature. These times were determined from the 3-inch temperature curve in figure 6. Several types of thermometers (mercury-in-glass, mercury-in-steel, bimetal, etc.) may be used. The bimetal thermometer encased in stainless steel and with a dial readout may be the most desirable, as it is inexpensive, easy to read, rugged, and sufficiently accurate for this purpose.

Figure 2. Two methods of recording temperature. Left is a gas-in-steel temperature sensor connected to a drum type recorder. Right is a strip chart recorder used for measuring temperature.

Soil temperature is a factor in winter hardiness of crops. Most winter grains do not survive temperatures much below 9° at the crown of the plant. Some relationships between soil temperatures and the changes within the plant as related to winter hardiness have been determined. However, the interactions between factors such as soil moisture, rate of soil temperature decline, minimum temperature for plant survival, and length of time the plant remains below freezing temperatures need to be investigated.

South Dakota has a special interest in soil temperatures since the northern boundary for winter wheat and barley production bisects the state. The state is on the fringes of the corn, sorghum and soybean growing areas. In order to expand producing areas for these crops, the soil temperature and/or the crops must be modified.

Characteristics and Implications

Soil temperature is affected by the type of ground cover, by the composition, density, and structure of the soil, by the amount of soil moisture, by the angle at which the solar energy strikes the soil surface, and by the weather.

The soil is a heat reservoir which stores energy during the day and emits it during the night. Therefore, the mean soil temperature at the planting depth is partially dependent on the temperature of the underlying soil as well as the air temperature. When air temperatures fall below soil temperatures, heat is lost from the soil to the air and this cools the upper layers of the soil. Simultaneously, heat flows from the lower layers to the upper layers of the soil and this reduces the magnitude of the cooling effect upon plants or germinating seeds in the soil.

Average daily soil temperatures measured at South Dakota State University Agronomy Farm, Brookings, in May 1967 are shown in figures 4 and 5. The temperatures in figure 4 were measured under spring-planted small grain, and the temperatures in figure 5 were measured under adjacent fall-planted small grain. April 1967, was a relatively cold month; average soil temperatures at planting depth were the same at the beginning of May as at the beginning of April. It is evident that most spring warming trends occurred during May.

Soil Depth Effects

Soil temperature fluctuations decrease as soil depth increases because they are damped out by energy stored at the deeper depths. This is evident in figures 4 and 5 and most of the other figures included here. Temperature changes at greater depths lage behind surface temperature changes. Figure 5 shows the average daily temperature at the 4-inch depth reached a maximum on May 25, whereas the 24-inch depth reached its peak temperature on May 28, three days later. It takes time for energy to move in and out of the soil profile.

The damping out of temperature fluctuations in the soil is also demonstrated in figure 6. These soil temperatures were recorded at 11 depths ranging from the surface to 5 feet below under a grain sorghum stubble at the SDSU Irrigation Experiment Farm near Redfield during May 1964. Temperature readings for each hour of the day were averaged over the entire month of May for each of the depths indicated in the figure. Note the relatively large fluctuations in temperatures during the day at the 3-inch depth. In comparison, fluctuations almost disappeared at the 18-inch depth. Figure 6 indicates that the maximum soil temperature occurs later in the day for successively greater depths and that the average soil temperature decreased with increased depth.

Soil temperature records in figure 7 through 9 were taken continuously under bluegrass sod as part of the weather measurements at the Agricultural Research Service Soil and Water Conservation Farm near Madison. Continuous records at the 4-, 8-, and 20-inch depths have been taken since 1962. Measurements at the 40-inch depth have been recorded since 1964.

Figure 7 depicts the maximum soil temperatures at each of four depths during May. The soil temperature at seed depth exceeds 55° daily throughout May. However, at the 8-inch depth, the soil temperature does not reach 55° until the middle of the month. Figure 8 shows that the average minimum soil temperatures remain below 55° until about May 20 for both the 4-inch and 8-inch depths.

Mean or Average Temperatures

Probably the most meaningful temperature measurement is the *mean* or *average* soil temperature for the day. The mean daily temperatures for the four depths are shown in figure 9. The daily values were obtained by taking the mean of the maximum and minimum temperature for each day. Mean soil temperatures above 55° were experienced after about May 14, and corn planting would start about May 17. During early weeks of growth, many of the nutrients needed by the plant are obtained from about the 8-inch depth. Mean temperature at the 8-inch depth reached the 55° mark shortly after it did at the 4-inch depth. Average soil temperatures at the 8-inch depth lagged the 4-inch temperatures by 2° to 3°. Soil temperatures at the 4-inch depth did not reach the 65° temperature considered by some as the desired minimum seedbed temperature for sorghum germination. However, these measurements were taken under sod and are not representative of normal seedbed conditions.

Soil temperatures were taken at the 4-inch depth in fall plowed ground during May 1967. These measurements were made within 100 yards of those taken under sod as mentioned in the preceding paragraph. Mean daily temperatures at the 4-inch depth under sod and in plowed ground for May 1967 are shown in figure 10. As would be expected, the mean temperature of the sod ground at the 4-inch level was below that of the plowed ground for most of the month. The 55° temperature at the 4-inch depth was reached by May 16 in plowed ground and by May 21 under sod. (The latter date is a week later than the longer-term average date shown in figure 9.) Therefore, it may be desirable to add several degrees to readings taken under sod if they are to be used in determining planting dates.

Inferences from Graphs

Important and valuable inferences can be made from the accompanying graphs:

Fields plowed in the fall and bare in the spring will usually warm up earlier (figure 10). This probably accounts for the frequent observations of better early spring growth in fall-plowed soil.

Fields covered with plant residues from minimum tillage will tend to have lower soil temperatures and slower seedling development in the spring than will fields without surface plant residues. If a residue mulch is used, some sacrifice must be made in early seedling growth due to lower temperature. Minimum tillage methods will require a slightly later planting date. However, the beneficial effects of minimum-tillage or mulch-tillage methods very often offset the effects of the lower spring soil temperatures.

South Dakota has a relatively short growing season. Farmers with large acreages of one crop cannot always afford to wait for the best possible planting conditions if they hope to harvest a crop of marketable quality. Selecting varieties that will readily germinate and grow at temperatures lower than the now-permissable minimum is one potential means of allevi-

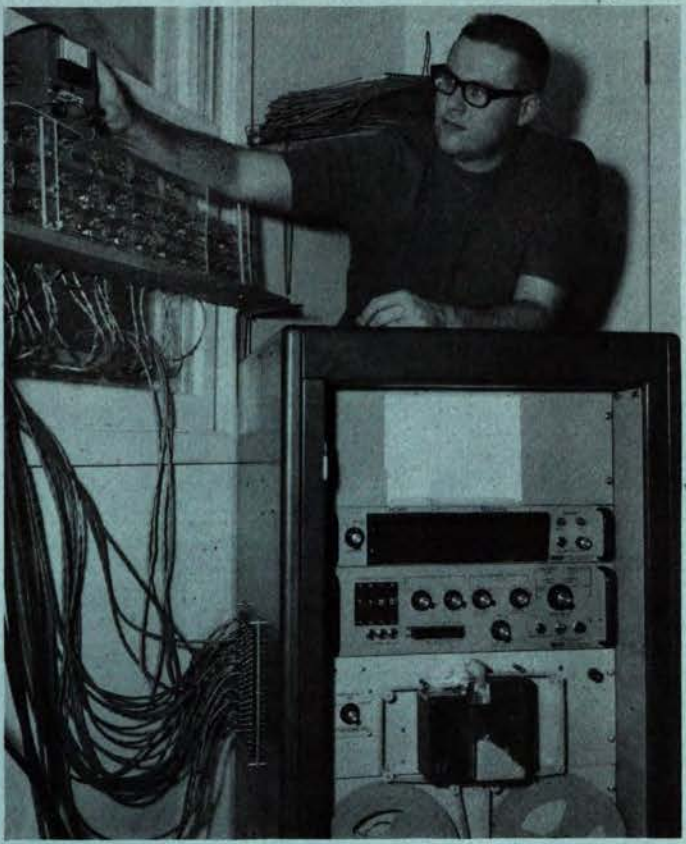
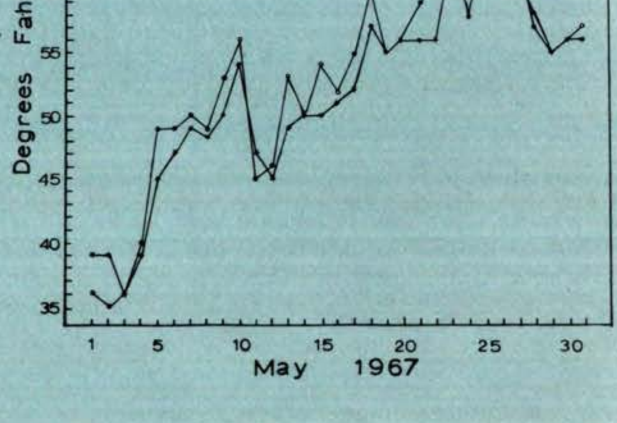


Figure 3. Paul D. Evenson, assistant professor in the plant science department demonstrates data logging equipment which is used for recording temperatures. Punched tape is processed by computer.

Figure 4. Average daily soil temperatures at two depths under spring-sown small grains at Brookings during May 1967.



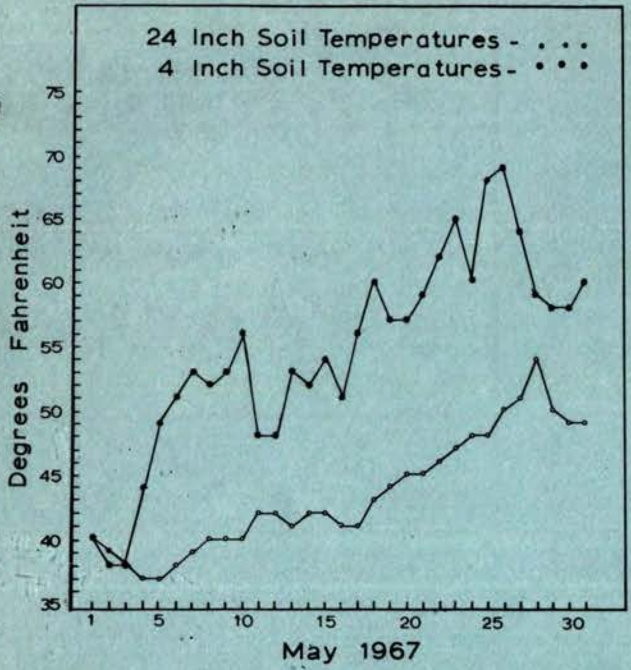


Figure 5. Average daily soil temperatures at two depths under fall-sown small grains at Brookings during May 1967.

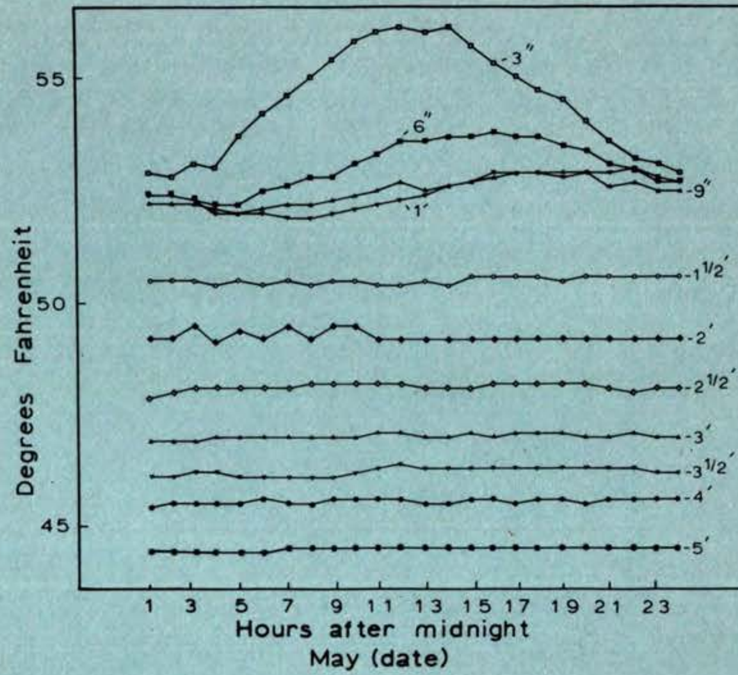


Figure 6. Average hourly soil temperatures at eleven depths under sorghum stubble at Redfield during May 1964.

ating this problem. If these were available, the farmer could lengthen his planting period by selecting several varieties to fit the changing planting conditions.

Research Continues

Research is continuing on the effects of soil temperature at planting time. This research will help in determining the best cultural methods available and aid in developing new ones. However, there is a growing need for more measurements of soil temperature to aid scientists in explaining past, present and future agricultural phenomena.

(Figures 9 and 10 and references cited on following page.)

Figure 7. Maximum May soil temperatures recorded at four depths under bluegrass sod at Madison, South Dakota.

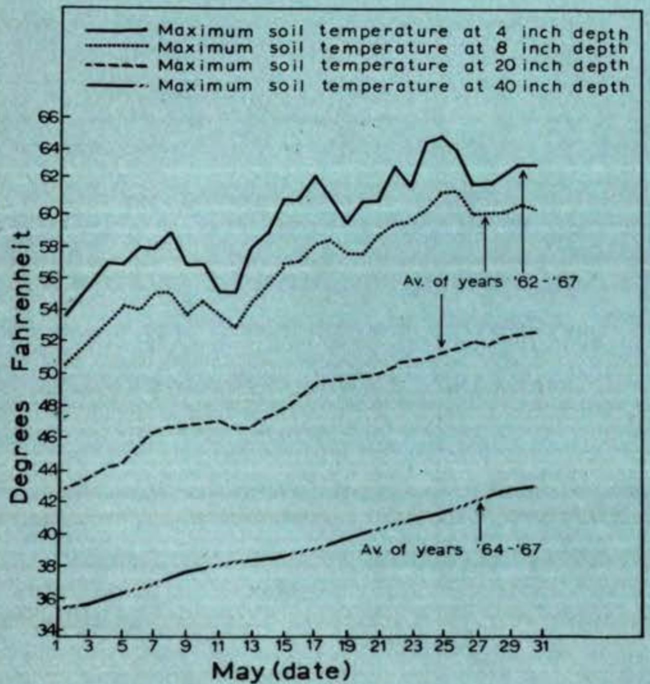
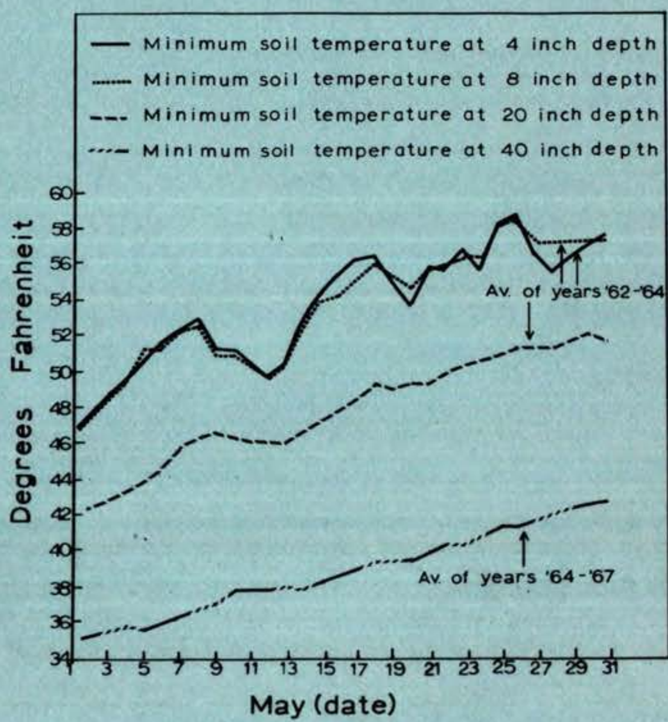


Figure 8. Minimum May soil temperatures recorded at four depths under bluegrass sod at Madison.



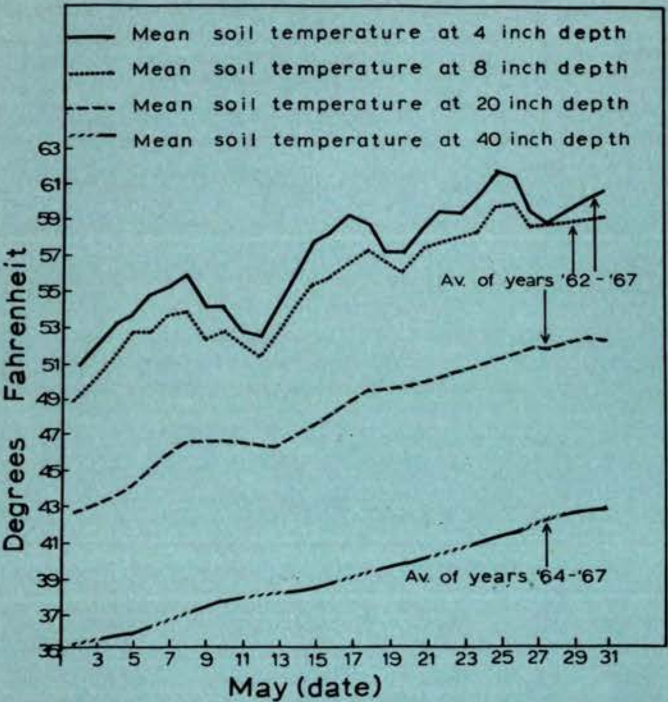
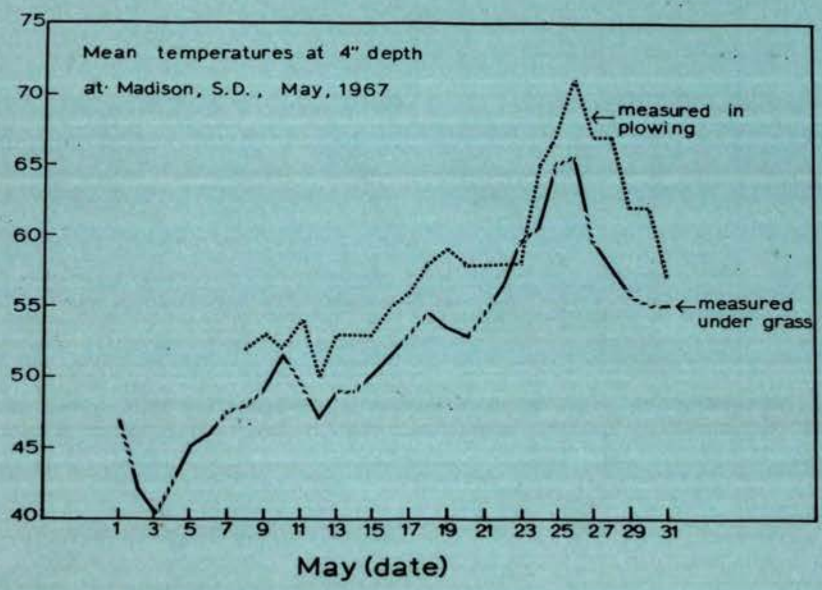


Figure 9. Mean May soil temperatures at four depths under bluegrass sod at Madison. Values are the average of daily maximum and minimum temperatures.

Figure 10. Average daily soil temperatures at the 4-inch depth under bluegrass sod and plowing at Madison during May 1967.



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Pheasan

Make Yearlong

Pheasants have long been what might be termed a single-purpose resource of South Dakota, used mainly to entice nimrods from far and near to a brief hunting season generally centered in the eastern part of the state.

Now, however, an attempt is being made to develop more diversified uses of the state's number 1 game bird – on a year 'round basis and potentially over a much larger area.

One phase of home economics research at South Dakota State University involves developing new food products to appeal either to the gourmet or to be served in restaurants. One such product is a pheasant pate that doesn't need refrigeration or mixing with mayonnaise or similar products. Research is still underway at the Agricultural Experiment Station to determine new freeze-drying and smoking methods for pheasant meat. Sauces to be used with pheasant are also freeze-dried and researchers check the appearance, taste and compatibility with pheasant.

Pheasant Artifacts

A second phase of current research is production of what are termed pheasant "artifacts." The decorative artifacts are made from cock pheasant feathers and would be aimed to appeal to a clientele not particularly concerned about price or durability. Pheasant feathers have been used for ties, hatbands, purses, collars, buttons, decorative braid and in woven fabrics, as well as for trim on note paper. Even a wedding veil was designed using the white feathers from the head for a decorative touch, as one would use sequins or pearls, on the crown and veil.

To provide the needed raw materials, home economists suggest the possibility of raising pheasants in a battery-fed situation, similar to methods used on large chicken production farms. For an individual this would probably involve raising several thousand pheasants a year to market both meat and cock feathers.

ts:

them a Resource

Varied Outlets

Outlets for the pheasant feather products might eventually be found in large speciality stores across the country and the meat sold through both gourmet outlets and in restaurants. A label would be needed, emphasizing both the pheasant and South Dakota, suggests Miss Frances Hettler, dean of the SDSU College of Home Economics. "What we need are pheasant products that do not read 'Made in Hong Kong' on the back," she adds.

Several problems remain to be solved. Because cock pheasants have more colorful plumage and are larger than hens, more of them would be needed. This poses the obvious advantage of a method of sexing pheasant chicks, again along the lines used by commercial poultry growers. Farmers or others willing to venture into the pheasant-raising business would be needed. If the operation became large enough, construction of a special meat-processing plant might be feasible. Because the feathers cannot withstand repeated washing or dry cleaning, decorative pieces on clothing should be removable. There could be a difference in flavor between the wild and battery-raised birds — this phase of the investigation is currently underway.

Dean Hettler believes a good market exists for both pheasant artifacts and gourmet products through speciality shops. The pheasant product business, she suggests, might develop into an industry capable of offering employment to many South Dakotans. A group of 50 to 100 persons probably could be employed initially, with the possibility of more workers if demand for the artifacts increased. Much of the

This pheasant feather collar is one of several "artifacts" designed in SDSU home economics research aimed at diversifying uses of South Dakota's famous game bird. Modeling the collar is Miss LaDonna Flaskey, Brandon, a senior in textiles and clothing. Miss Dorothy Stoflet, professor in textiles and clothing, designed the collar and the wedding veil shown on the next page.

One phase of nutrition and food science research at SDSU seeks ways of counteracting a tendency of meat to become tougher when preserved by freeze drying. Mrs. Dorothy Deethardt of the home economics research staff places diced pheasant meat into a freeze drying unit which, in this case, is regulated to provide a vacuum and temperatures of around 50 degrees below zero. Wire thermocouples provide average temperature readings for each of several compartments in the tray which will remain in the unit 15-18 hours before removal.

Wool and pheasant feathers — two South Dakota products — are combined to make this wall hanging (above) shown by Miss Diane Quissell, a senior textiles and clothing major at SDSU. The feathers form the dark horizontal lines. Miss Quissell is from Jasper, Minn. The wall hanging was woven by Miss Anita Moore, professor emeritus in art.

work would not demand special skills.

Expand Growing Area

With a battery-fed operation, pheasants could be raised throughout South Dakota rather than in just the eastern part of the state, where wild pheasants are most plentiful. Eggs to start the operation would be available from commercial sources. A commercial pheasant operation near Canton that provides products mainly for sale out-of-state is cited by Dean Hettler as an example of production of the basic resource needed for expansion and diversification of uses of the pheasant.

According to Dean Hettler, pheasants raised in a battery-fed environment do very well, and she feels that there would be no difficulty in finding a market for the products. Another possibility raised by Dean Hettler is weaving the feathers with South Dakota-grown wool for clothing material, thereby utilizing two local products.

By whetting the interest of South Dakotans, the potentials of raising pheasants, manufacturing artifacts, setting up a processing plant, and marketing to a nationwide clientele, "could develop into a substantial boost for the South Dakota economy," says the Dean

White feathers from a cock pheasant's neck and sequins are combined in this wedding veil, designed as part of SDSU research seeking additional uses for South Dakota's No. 1 game bird. The white feathers form a ring on the pillbox base as well as occasional highlighting on the veil itself. Miss Carole Sieverson, a freshman in textiles and clothing from LaBolt, shows the veil.

South Livestock Auction Markets

Growth and Economies of Scale

By
Robert L. Beck, associate professor, Department of Economics

Auction markets have traditionally been a vital institution in marketing South Dakota livestock. They have provided the producer with a nearby competitive market.

The Economics Department at South Dakota State University has conducted several studies relating to the development, role, costs, needed adjustments, and future possibilities of South Dakota livestock auction markets. The most recent study was made by Robert L. Beck, formerly associate professor, and Donald K. Bendt, a graduate student of Clear Lake, S. D. Findings have been reported in Bendt's master's degree thesis and in Agricultural Experiment Station Bulletin 560, "An Economics Analysis of Livestock Auctions in South Dakota," the latter available through County Extension offices or the Bulletin Room, SDSU.

In this first of two articles based upon these studies, Dr. Beck discusses growth, location and operation of livestock auction markets. In a following issue of South Dakota Farm & Home Research he will discuss areas of needed adjustments in the auctions.

Dakota

Growth and expansion are key words in the definition of any successful business operation. While growth is considered necessary, the means and extent are largely left to individual action and decision. Livestock auction markets, as a business enterprise, are no exception. They, too, are faced with the problem of growth, although not necessarily in physical facilities, and expansion of volume to remain competitive.

Growth and expansion are usually viewed as a means of providing a basis for better service and more competition by reducing unit cost of operations which spreads fixed costs over more units and thus lowers per-unit costs of operation. Thus, one might logically ask: what economies of scale are associated with larger livestock auctions? How many animal units must an auction handle in order to reach the "break-even" point? Recent studies give some indication of the growth in South Dakota livestock auction markets as well as the economies of scale associated with size.

Growth of Auction Markets

Physical Facilities

Livestock auction markets in South Dakota since 1956 have substantially increased their investment in facilities and equipment. In 1964, average investment in fixed facilities and equipment for a medium auction, and $40,000 for a small auction. (Auctions are divided into these size groups based upon the number of marketing units handled: large – 50,000 or more; medium – 30,000-49,999; small – less than 30,000) This rep-small – less than 30,000). This represented an investment of $1.59, $1.74, and $2.29 respectively, per marketing unit (m.u.). During the period of 1956-1964, yard capacity was increased by 41 auctions while 8 markets added additional barns. Others built additional rings, overhead walkways and other facilities.

Volume

The number of livestock marketed through South Dakota auctions has also increased (figure 1). In fiscal year 1967-68, over 2 million cattle, 1 million hogs, and 431,000 sheep were sold through auctions. This represented substantial increases over previous years. Indications are that the proportion of livestock being marketed through auctions is increasing. In 1957, an estimated 34% of the South Dakota cattle marketed, 20% of the hogs, and 19% of the sheep were marketed through auctions. By 1964, these proportions had increased to 48%, 23%, and 34% respectively.

Growth of auction markets is also reflected in distribution of markets by size category (table 1). In fiscal 1948-49, practically all auctions (49 of 54) handled less than 30,000 m.u. Three markets were classified as medium and only two as large. Just two decades later (fiscal 1967-68) there were 22 large, 11 medium and 24 small auctions operating. During the same period, the average number of m.u. handled per auction increased from 14,879 to 43,576. The geographic location and size distribution of these auction markets in 1967-68 is shown in figure 2.

Cost-Volume Relationship

What has been the impact of this increased volume upon costs? Is there an

Figure 1. Number of cattle, hogs and sheep marketed through livestock auctions, South Dakota, 1937-1967.

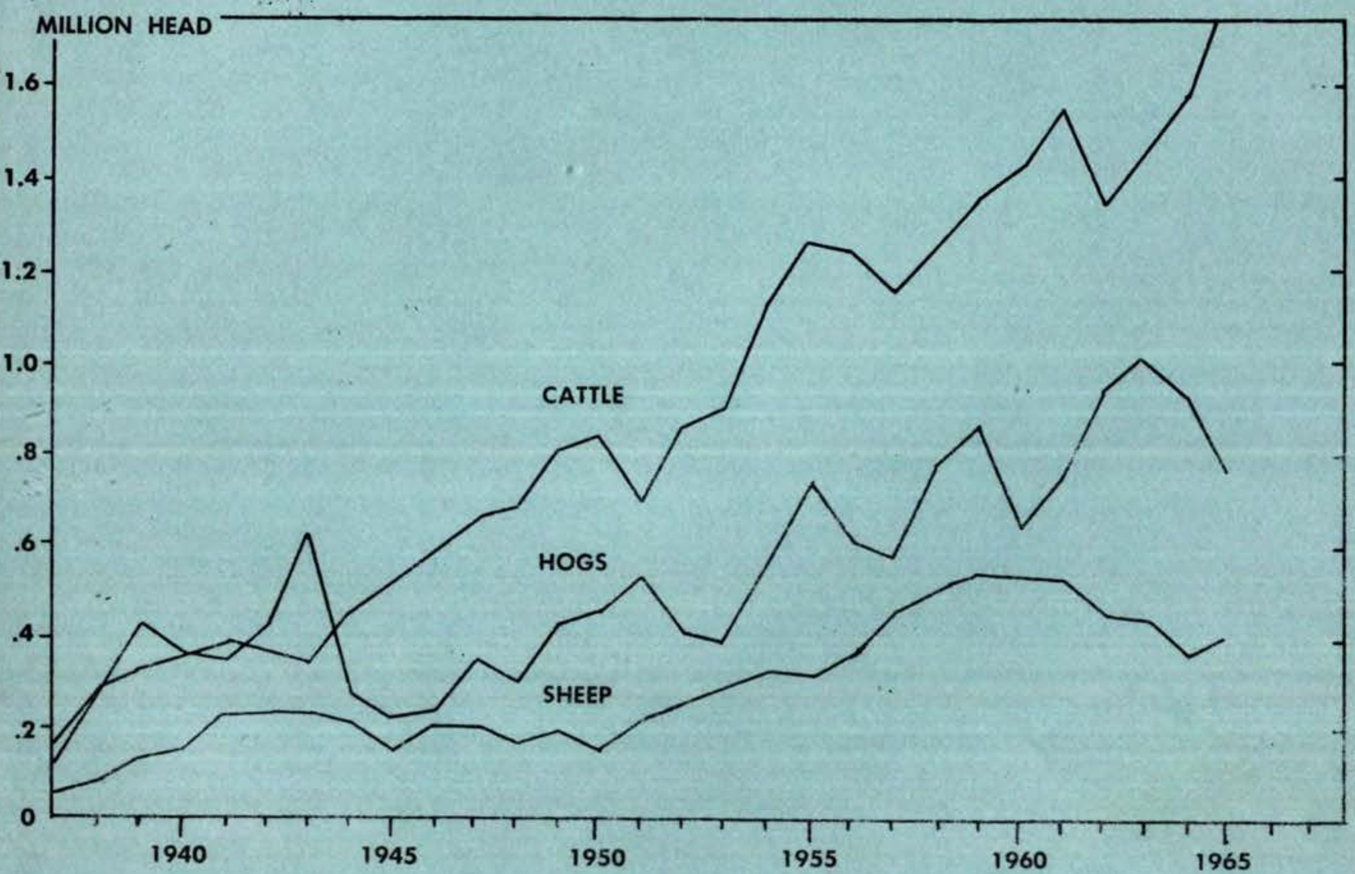

Table 1. Distribution of auction markets by size category, South Dakota, 1948-49 and 1967-68

Auction size	1948-49	1967-68
	Number of auctions	
Small	49	24
Medium	3	11
Large	2	22
Total	54	57
Average m. u. sold per auction	14,879	43,576

apparent reduction in per-unit costs associated with larger auctions?

Cost data of 21 selected auctions tend to indicate that, except for those handling less than 10,000 m.u., there was little relation between volume and per-unit costs. This is illustrated in the scatter diagram of average per-unit costs in figure 3. Wile the differences are not great, they do indicate that it may be difficult for smaller auctions to compete cost-wise. They may, however, compete by providing valuable services such as livestock assembly which otherwise might not be available to producers in some areas.

When considering expansion and growth, management should also be concerned with the "break-even" points for various size operations. Given operational costs and marketing charges, the "break-even" point represents the minimum number of marketing units necessary to generate enough revenue to exactly meet the costs of operating. Thus, it is necessary to operate above that minimum number in order to realize a profit.

Based upon cost estimates and marketing charges assessed by a group of 21 auction markets, break-even points were estimated for various size markets up to 75,000 marketing units. These are shown in figure 4.

While most markets operated with volumes above their respective break-even point figure 4 suggests that auctions handling less than 10,000 m.u. might have difficulty in maintaining profitable operations. An auction which incurs the costs required to handle 10,000 m.u. annually would reach the break-even point at about 8,300 units. The break-even point for an auction handling 60,000 m.u. is about 46,000 units.

Naturally, as costs or marketing charges change, the break-even point will shift. However, the concept is useful in approximating profitability of any given size of operation.

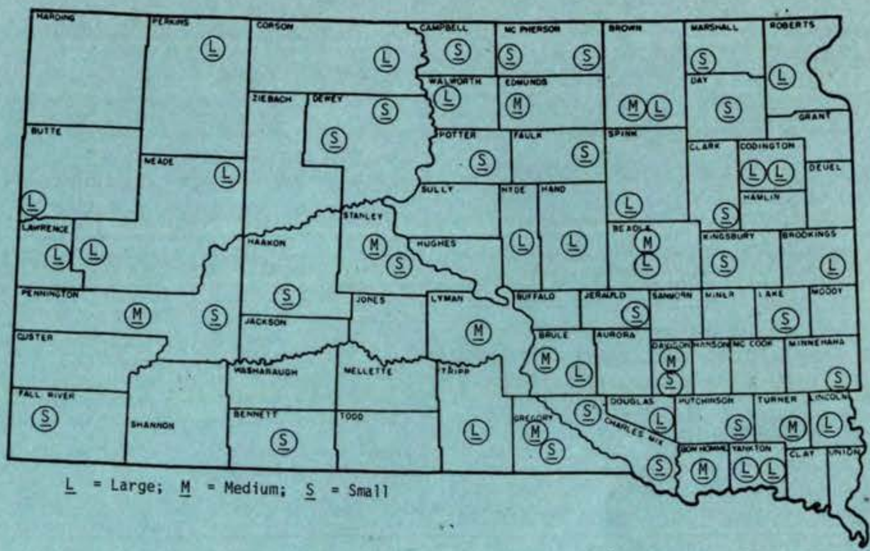

Figure 2. Location of livestock auction markets in South Dakota, 1967-68.

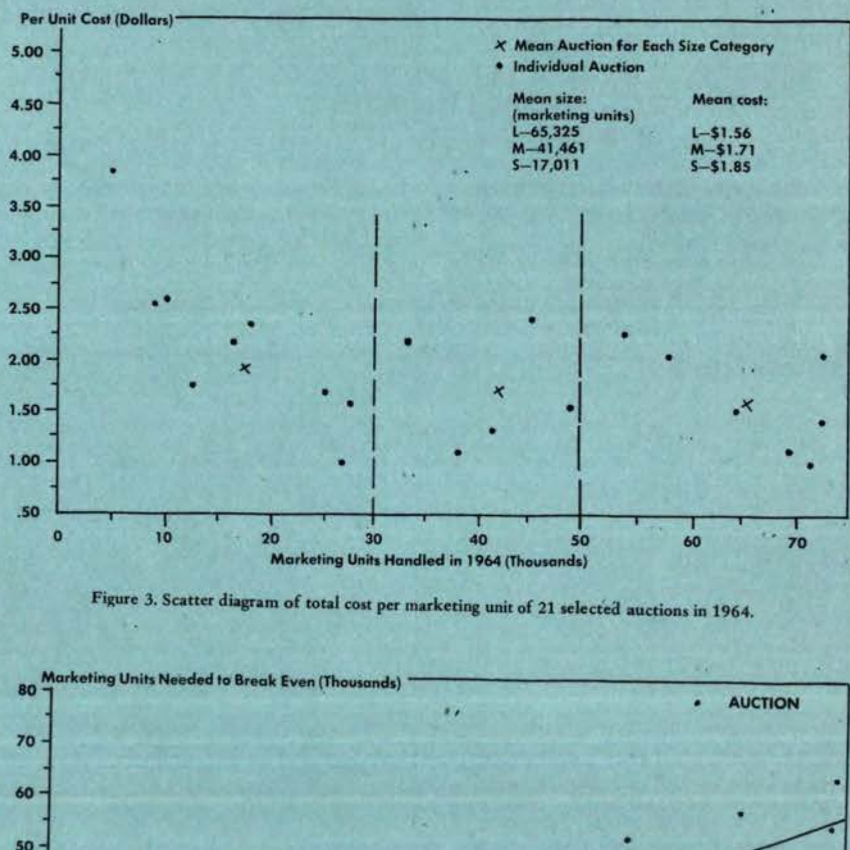

Figure 3. Scatter diagram of total cost per marketing unit of 21 selected auctions in 1964.

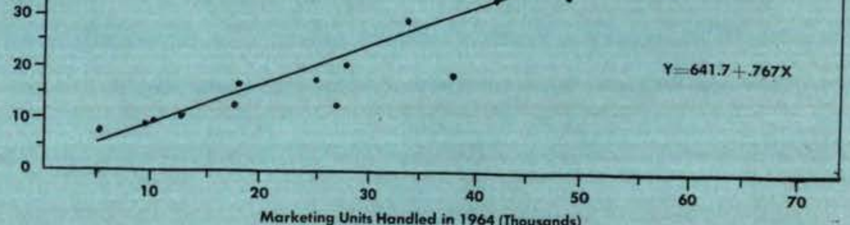

Figure 4. Break-even points of 21 selected auctions, 1964. (Note: The line represents the average number of marketing units required to break-even for the various size auctions, based upon operating costs in 1964.)

Seasonality of Marketing Manufacturing Milk

Seasonal variations in deliveries of milk lead to serious marketing problems. A fairly uniform pattern of marketing milk from month to month is desirable from the standpoint of both the producer and processor.

From a farm management viewpoint, uniform production tends to result in a higher annual production and greater income per cow. Directly affecting the processor, and indirectly the producer, is the impact of seasonal variations on marketing costs. Seasonality results in increased processing costs because both labor and equipment cannot be used to capacity. Costs of storing the finished products are also increased because production is out of line with market needs. In addition, variations in marketing affect assembly costs. It is costly to haul small loads of milk in the shortage season.

While seasonality is not unique to South Dakota's dairy industry, it is of such magnitude to warrant attention. Through seasonal pricing programs, some progress has been made in encouraging a more uniform supply of fluid milk. Unfortunately, however, little has been accomplished in the manufacturing milk segment. Not only must this segment cope with variations in the supply of manufacturing milk, but it also becomes the residual market for surplus milk from the fluid sector. Thus, the seasonality of the total industry is carried mainly by the manufacturing milk segment.

Considerable Seasonality

In South Dakota, there is pronounced seasonal variability of marketing manufacturing milk.[1] In 1968, for example,

More detailed information on milk marketing may be obtained from Agricultural Experiment Station Bulletin 563, "Seasonal Marketing of Manufacturing Milk — Associated Factors in Eastern South Dakota," available through county Extension offices or the Bulletin Room, SDSU.

[1] *Data showing seasonal variability of marketing manufacturing milk are not readily available. However, the use of total production to illustrate seasonal variation in marketing seems logical since approximately three-fourths of total milk production is used in manufactured milk products.*

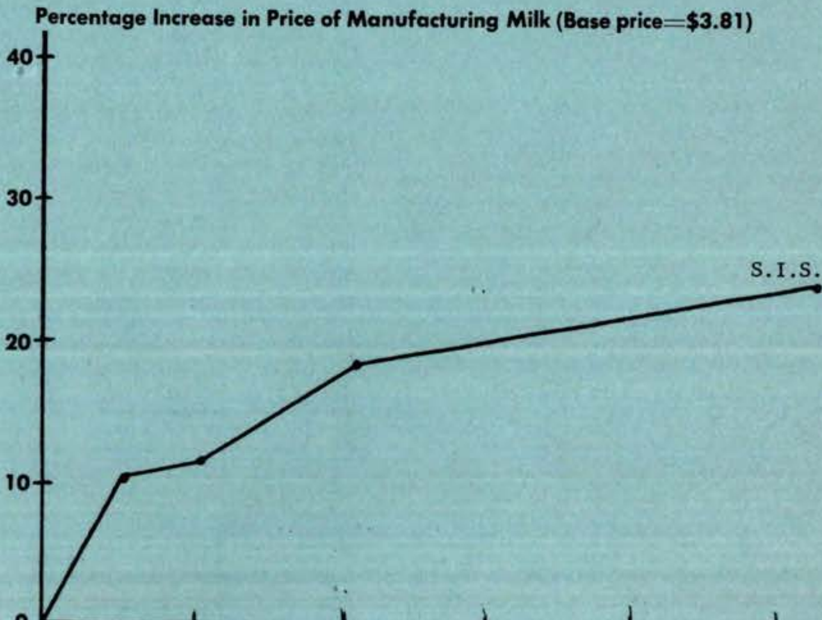

Figure 1—Producers' seasonal incentive supply, sampled producers, eastern South Dakota, 1966.

By
Robert L. Beck, associate professor, and Larry G. Traub, graduate assistant, Department of Economics.

total milk production varied from a high of 163 million pounds in June to a low of 107 million pounds in November – a 34% decrease.

Because of problems associated with this extreme variation in market receipts a study, "Factors Affecting the Seasonality of Marketing Manufacturing Milk in Eastern South Dakota," was used to identify some factors associated with the seasonal pattern of marketing manufacturing milk as well as to determine some adjustments necessary to reduce seasonal fluctuations. Data pertaining to general farm characteristics, dairy operations, management, marketing practices and factors associated with seasonality of production were obtained through personal interviews from a random sample of 75 manufacturing milk producers in Eastern South Dakota. From these data, it was possible to: (1) analyze producers' reactions to a seasonal pricing plan, (2) determine the nature and extent of adjustments, and (3) identify obstacles to these adjustments in bringing about a more uniform flow of milk to the market.

Seasonal Pricing

The principle of seasonal pricing was studied to evaluate incentives needed to induce producers to increase production during the seasonally low months. It is often suggested that producers will supply the additional quantity of milk during the low production months if the additional or marginal return is at least equal to marginal cost.

In this study, seasonal supply price was defined as a price offered during a specific season to induce producers to increase the quantity of milk supplied during that season. Seasonal incentive supply was used to mean a schedule of percentage increases in quantity offered for sale with various percentage increases in seasonal price above the "normal" price. Each producer was asked to indicate the seasonal supply price necessary to bring about an increase in production of 5%, 10%, 20% 25% and 50% during months of normally low production. Results are shown in figure 1. These responses indicate that a 10% increase in price is necessary to bring about a 5% increase in milk production during the low months. However, as the seasonal supply price increased, producers indicated a greater degree of responsiveness. In general, a substantial increase in price (about 20%) would be necessary to increase flow of milk to market during the seasonally low months of production.

Table 1. Operational adjustments necessary for increased seasonal production, sampled producers, eastern South Dakota, 1966.

Adjustments	Number of responses
Change in the season of freshening	42
Increase dairy herd size	37
Improve the quality of the dairy herd through replacement with higher producing cows	36
Improve feed ration	27
Improve the quality of the dairy herd through improved breeding practices	13

Operational Adjustments

Increasing the supply of milk in periods of low production requires some adjustments in operations. In an attempt to determine the nature and extent of these adjustments, each producer was asked to indicate those changes in operations necessary for increased production in seasonally low months (see table 1).

One operational adjustment which more than half of the producers believed necessary was a change in the season of freshening (table 1).

Improvements in the quality of the dairy herd either through replacement with higher producing cows or through improved breeding practices also ranked high among producers as a necessary change in operations.

Almost half of the producers listed increasing herd size as one method of adjusting seasonal production. Improving the feed ration during the season of low production was mentioned by more than a third of the respondents. Because of the flexibility in feeding practices, variations in feeding rates may provide a partial solution to the problem. Other dairy operations, however, do not possess the same degree of flexibility.

Barriers to Adjustments

To get some idea of the extent and magnitude of the obstacles faced by producers in modifying their marketing patterns, each respondent was asked to identify three of the major obstacles (listed in table 2) preventing an increase in production during the months of normally low production. In each case, a follow-up question was asked to determine the nature of these obstacles.

Shortage of fall pasture and hay was the most frequently mentioned barrier. Weather was listed as the major reason for the shortage. A number of producers listed the breeding rotation as a barrier and indicated some hesitancy in changing the rotation for the herd.

Insufficient number of cows and shortage or high cost of labor were frequently listed as obstacles. If additional cows are bought for the seasonal time period and are sold afterwards, and likewise with the hiring and releasing of additional labor, these changes can be effective in increasing milk production during the seasonal time period. But, if the additional cows and labor are retained, total milk supply will probably increase with little or no effect on the seasonal pattern of marketing.

Inadequate price per hundredweight and higher cost of feed were listed as obstacles by some respondents, indicating the possible effectiveness of price incentives. A limited number of producers cited the lack of operating capital as a barrier to seasonal adjustment.

In summary, there are a number of obstacles to changing the seasonal pattern of marketing manufacturing milk. Some of these are major adjustments at the farm level which will take time (breeding programs, for example) and some are adjustments which are costly (shortage and cost of feed in fall months). The latter implies that the cost of producing milk during the fall and winter months is greater. Thus, any adjustment by the producer will most likely be in response to a price incentive duri this period. Producers expressed a willingness to increase production during normally low months – for a price. However, to bring about the amount of increase necessary to level out market receipts, a substantial increase in price during the seasonally low months would be needed.

Table 2. Obstacles preventing increased milk production in seasonally low months, sampled producers, eastern South Dakota, 1966.

Obstacles	Number of responses
Shortage of fall pasture and hay	60
Breeding rotation not properly regulated	32
Insufficient number of cows	27
Shortage or high cost of labor	23
High cost of feed	16
Lack of operating capital	12
Already producing heavily in fall months	10
Inadequate price per hundredweight	8
Other obstacles*	13

*Other obstacles are: facilities already used to capacity, hot weather, vacation, flies, lack of interest, other enterprises, and unable to feed the dariy herd better.

Acoustical Ear Muffs for Protection of Hearing and Health

"Now that guy must really be a radio buff," mused the speeding motorist as he passed a farmer plowing a dusty field. "He's wearing headphones, probably listening to some good old country music."

Not necessarily so.

It's quite likely the farmer was wearing ear muffs, not headphones, and the only "music" he heard was the toned-down rhythm of his machinery or tractor. This type of ear muff is different in construction, and purpose, from the well-known ear warmers.

Although some enterprising farmers do hook up these ear muffs to also listen to a radio, their main concern is agricultural machinery noise and how to deaden it to lessen dangers of permanent hearing loss. Acoustical ear muffs — such devices now sometimes go by the uptown name of "ear defenders" — are a cheap and effective way to do it. So are industrial-type earplugs but they usually need individual fitting and must be kept clean when used in dirty surroundings. A sound proofed tractor cab may also do the trick, although this is more expensive. "Home-made" wax or cotton plugs stuffed into the ears do not offer sufficient protection.

See Extensive Use

A couple of South Dakota State University agricultural engineers, who made a special study of acoustical ear muffs, believe before too long many Upper Midwest farmers will wear this type of ear defender part of the time when working around noisy machinery. The engineers base their estimates on reaction of a dozen farmers who were willing to take the trouble to test the ear muffs during spring and fall farm work. The engineers found that acoustical ear muffs reduced noise to acceptable levels although the matter of comfort, convenience and personal choice also entered into the picture.

In all but one case use of ear muffs got a favorable reaction from the cooperators. However, they conceded a person would need to "learn" to wear them. "At first the ear muffs gave me a sensation of going around with my head under water," said one of the farmers. However, most of them said they'd take the relatively small discomfort from side pressure on the head especially if it meant less exposure to possible damage to hearing. But one operator decided the ear muffs were a "big bother" and didn't use them.

Nowadays there's not so much silence about noise. It is recognized as a bothersome pollutant as well as a direct threat to hearing. It even takes a toll in subtle psychological and physiological ways, according to some experts. The farmer is now also learning that as far as hearing loss is concerned, his noisy machinery is a dangerous threat to any member of his family — especially when exposure is over prolonged periods.

Tractor Noise Damaging

Agricultural engineers and others say that many tractors now used on farms are noisy enough to cause permanent hearing loss to persons operating them. Most tractors used in the South Dakota studies, although all were equipped with cabs, were far nosier than the level researchers set as acceptable. Measurements in which ear muffs were used showed noise was reduced to acceptable levels on all but one tractor. The "acceptable level" corresponded to 85 decibels, a decibel being a relative loudness measurement unit on a scale beginning with 1 for the faintest sound.

Merely installing a cab on a tractor many times makes it actually noisier inside for the operator than without a cab, studies at SDSU and elsewhere show. Manufacturers also are becoming more concerned and some of the 1970 model cabs are better designed for noise control.

One main factor in hearing loss from loud noise is exposure over prolonged periods of time, as would be the case in many instances involving operation of farm machinery too long and too often. Wearing ear muffs less than 100% of the time

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One "ear defender" source . . .

Members of the Mechanized Ag Club at South Dakota State University plan to obtain a supply of acoustical ear muffs and make them available to farmers.

The club of more than 100 members is made up of SDSU students taking mechanized agriculture courses.

Initially club members plan to contact farmers in their communities to show the ear muffs and explain how Agricultural Experiment Station research has found that the devices can help reduce noise that possibly might cause damage to hearing.

The small profit from each sale will go into a club activity fund. The club assists in the machinery show in connection with the Little International at SDSU each year and plans are being made to engage in other activities involving high school students in farm safety programs.

Harvey G. Young, assistant professor of agricultural engineering, is club adviser. Additional information on ear muff cost or other details may be obtained through Young at the Ag Engineering Department, SDSU, Brookings, 57006.

— as some farmers did in the SDSU study — will tend to help reduce damage.

Some ear doctors say continuous noise levels below 90 decibels probably wouldn't cause deafness. At the same time, they point out, the louder the noise above 90 decibels the greater chance of irreversible noise-induced hearing loss.

Just where does the 85- or 90-decibel "danger level" begin? Generally, it can be illustrated as someplace between heavy street traffic noise and that from a pneumatic drill, loud radio, — even from some food blenders. Overall background noise from a rock-and-roll establishment was once clocked at 100 decibels, with peaks of around 120 — which approach the threshold of discomfort and equal noise from an airplane or close thunder but not quite as bad as a shotgun blast.

For several years Paul K. Turnquist, SDSU agricultural engineer who splits his time in research and teaching, has been interested in noise abatement. His interest was aroused upon learning that over the years SDSU freshmen hearing tests often revealed a higher-than-average incidence of hearing impairment, reflected mostly from young people with farm backgrounds. In 1968, for instance, 15.4% of the male students had some type of hearing problem. This was about twice the national average. Again, most of this group had been exposed to farm machinery noise.

Some inconvenience in getting into and out of the tractor cab is one factor in the use of acoustical ear muffs to protect hearing against loud noise, according to research at South Dakota State University. Most farmers in the study said they would take a little inconvenience if their hearing was protected. Harlin J. Trefz, a former SDSU student from Onaka, S.D., is shown wearing the type of ear muffs used in the research.

Turnquist interested several of his graduate students in the noise problem. The approach was to find practical, economical ways of deadening noise from thousands of agricultural machines now in use. After all, the teacher and students reasoned, a farmer who already owns a suitable, but noisy, machine costing several thousand dollars isn't likely to get rid of it just because somebody says it will affect his hearing. Besides, facilities and personnel were not available at SDSU to go into design and testing of new, quieter agricultural machinery. "That's up to industry," said the SDSU ag engineers, "we'll stick to putting some type of barrier between the sound source and the offended ear."

Turnquist's first students worked at refinements in methods of measuring machinery noise. Later, others helped work out a do-it-yourself system of installing acoustical foam to the inside of tractor cabs which reduced noise levels below the danger point.

A farmer-visitor at the SDSU Agricultural Engineering Department about a year ago furthered Turnquist's interest in acoustical ear muffs. The farmer happened to mention that he, too, was interested in deadening tractor noise and had been trying a new type, lightweight ear muff manufactured by a mine safety firm. He thought the device helped. Although he didn't claim to be a noise expert, he know about the effects of loud noise on hearing as a result of experience in World War II as an artilleryman.

Acoustical ear muffs were found to be an economical and effective device to deaden noise from agricultural machinery. The lightweight type shown here cost about $6.

About this time Harlin J. Trefz, a farm boy of Onaka in north central South Dakota, just out of the service and with a B.S. degree in agricultural engineering at SDSU, decided to continue in graduate work. Under Turnquist's supervison he did his research on acoustical ear muffs, mainly concerned with finding out if farmers would actually use them — if not, why; if so, why.

Trefz, who now works for International Harvester Company near Chicago, in summing up the ear muff study makes these additional points:

*Nine of the 12 cooperators had their hearing checked and all had some degree of hearing loss, attributed mainly to earlier excessive tractor noise.

*Age didn't have anything to do with amount of time cooperators used the ear muffs. Their ages ranged from 21 years to 61 years.

*Type of field operation affected ear muff use. Cooperators used the ear muffs 75% of the time for tillage operations, only 44% of the time for seeding small grain. Power take-off operations, chopping silage, picking corn, as well as planting small grain and corn saw less use of ear muffs mainly because of inconvenience of wearing them when frequently dismounting from the cab, inability to hear the machine well enough to judge its performance, and lowered noise level from less power used.

*Temperatures, as might be expected, had an effect on ear muff use. Eight cooperators said the ear devices were uncomfortable to wear at cab temperatures of 75-90 degrees, although others said heat was no problem for them.

*Loudness of the tractor didn't affect the amount (in hours) of ear muff use. (Sometimes in the past, the man with the loudest tractor was thought to have the one with the most horsepower.)

*Eight of the 12 operators had tractor radios. Three said they could hear the radio better with the ear muffs on, three felt it made no difference, two heard the radio better with ear muffs off. One operator was well satisfied with a gimmick he made: he installed stereo speakers from an AM-FM radio in the ear muffs.

*Maximum time the ear muffs were worn continuously ranged from a half hour to 12 hours with the average about 4½ hours. About half of the operators wore the ear muffs more than 10 hours continuously. Most had to become accustomed to wearing the devices. Six said they were less fatigued at the end of the day after wearing the ear muffs.

*Range of ear muff use ranged from 100% to zero. Four cooperators wore the devices more than 85% of the time, five between 40% and 67% of the time.

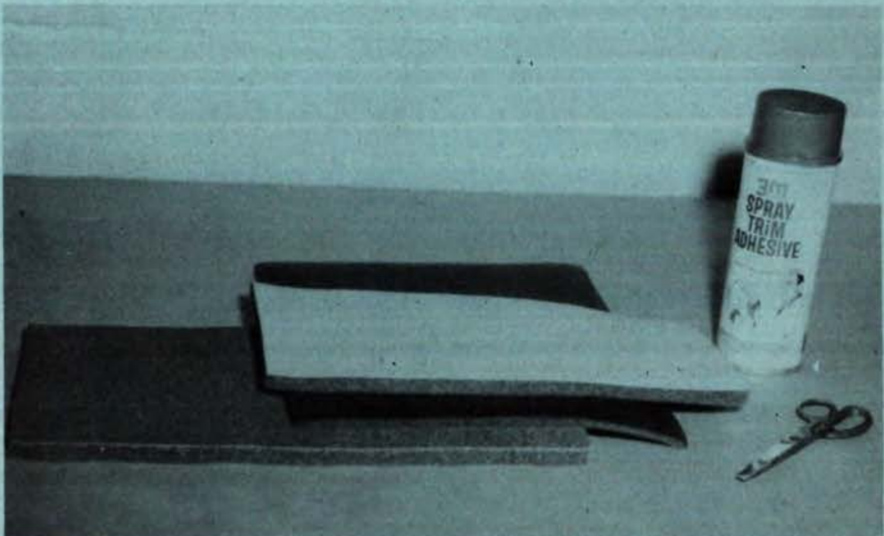
*A total of 1,565 hours of ear muff use was logged by all cooperators during the study.

This is a portable sound analyzer, used in SDSU research to measure agricultural machinery noise. A microphone (not shown) picks up the noise from the tractor. The instrument prints out data used in figuring noise levels under differing conditions.

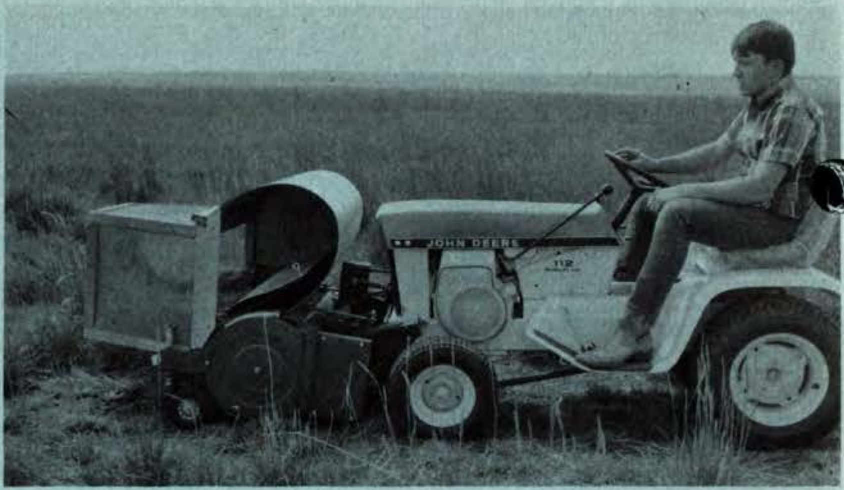
HEARING DAMAGE NOT ONLY DANGER

Former Surgeon General William H. Stewart says: "It has been demonstrated that noise can cause physiological changes. These include cardiovascular, glandular and respiratory problems reflective of a generalized stress reaction."

Then there is another possible reason for noise reduction: domestic tranquility. A recent study reveals that steelworkers working in especially noisy surroundings tend to argue increasingly on the job and at home. Another study indicates that people working at noisy jobs are apt to show more fatigue signs and have more neurotic problems than other workers.



Acoustical foam, adhesive, and a pair of scissors are main items needed to insulate the inside of a tractor cab, which is another, do-it-yourself method of deadening loud tractor noise to levels where it is not a danger to hearing. Industrial type earplugs and ear muffs are also effective noise deadeners, each with certain advantages and disadvantages. Home-made wax or cotton earplugs stuffed into the ears are not recommended protection against hearing damage.



Part of the research involving use of fertilizers on South Dakota grasslands is being done by Gregory K. Grenz, SDSU graduate student from Eureka. The implement is part of an adaptation of a commercial flail he designed and made for use on a small tractor to harvest experimental plots at the Pasture Research Center near Norbeck last summer.

An operator can "aim" the tractor along the somewhat exacting boundaries of the 14 x 21-foot experimental plots. The side of the flail adaptation is shown open here to illustrate how cut grass is thrown around the steel sheet to land in the collecting box.

GRASSLAND FERTILIZER RESEARCH AT NORBECK

When, what, where, why and how do you use fertilizer to boost yields of South Dakota grasslands?

You'll probably be getting some of the answers to these questions within the next year or two as a result of research which started last year at the Pasture Research Center operated by the Agricultural Experiment Station near Norbeck in north-central South Dakota.

When the data is all in, South Dakota State University agronomists hope to have answers relating to when fertilizers should be applied (mainly spring vs. fall), what fertilizers to use, where and perhaps how to place them, and why they are needed.

Although the 2,700-acre leased unit making up the Center has a variety of research activities underway, all relate to methods of gaining more dollars per acre from grasslands, according to Raymond A. Moore, head of the Plant Science Department at South Dakota State University. "We think we've already had some success in getting information that will help grassland farmers boost their income," says Dr. Moore, who was in charge of the Norbeck project before becoming department head last year. Cooperating in the projects are the SDSU departments of Animal Science, Economics, and Horticulture-Forestry.

Varied Research Work

Research includes a cow-calf operation of 300 head of cows plus about 200 yearlings. The numerous pastures include those of cropland seeded to various species and mixtures of grass, as well as native pastures. Some are used for early or late grazing, others during the warm season. About 400 acres of native pastures are for reserve grazing and hay. Fertilizer, weed control and interseeding studies are in these reserve areas. An additional 400 acres are farmed in a regular rotation to produce hay, silage, and cash crops. Agricultural Experiment Station personnel are squeezing every bit of information possible out of the Center. They are even involved in landscaping and improving the farm house and immediate surroundings.

Dr. Moore says that after 3 years of research it is evident well managed pastures can compete favorably with cash crops in this Faulk County area. For example, net return of highest producing pastures was equivalent to a 30-bushel spring wheat crop in 1968 – in both cases the net return amounting to $17 an acre.

Wheat, Silage Yields Up

Half of each experimental crop field is fertilized according to soil test recommendations and half is left as a check, or not fertilized, Dr. Moore says. Row crops are rotated with small grains but the same half of each field is always fertilized for the crop being grown. Following only a minimum response to fertilizer in the early years of research, differences are now evident at all seasons of the year and are reflected in yield. He points out that spring wheat on the fertilized acreage averaged 35 bushels an acre, while that on the land without fertilizer averaged only 27 bushels in 1968. Silage yields of corn have been boosted on an average of up to 2 tons an acre.

The newer research with fertilizers for grasslands in a sense might be termed a "pilot" study, according to the SDSU agronomist. This is because some of the information obtained will be used later for large field-scale studies with livestock.

Trace Elements

Several rates of both primary and secondary (trace) elements of various forms are included in these preliminary studies, as well as dates of application for both spring and fall. These combinations are being used on several grasses and grass-legume combinations including crested wheatgrass, western wheatgrass, smooth brome, Russian wildrye, switchgrass, bluegrass, and a mixture of smooth bromegrass, intermediate wheatgrass, and alfalfa.

Growing all of these combinations is only part of the research task. After being harvested from experimental plots, the samples must then be analyzed for protein content, dry matter yield, carryover effect of fertilizers, and cost figures. This information for only one year of studies should be available later this spring. Information from at least another growing season is needed before preliminary recommendations can be made.

Commercial Fertilizers for South Dakota Grasslands

One capped and gowned participant marching off the South Dakota State University graduation stage with master's degree in hand next year has hopes his educational efforts will pay off for South Dakota grassland farmers and ranchers as well as for himself.

At least that is the way plans have been made by Gregory K. Grenz, 21, of Eureka in northwestern McPherson County.

Grenz graduated from SDSU in the spring of 1969 with a B.S. degree in agronomy. With hardly a break in stride he soon found himself living in a trailer on the wide open spaces of the Pasture Research Center, a major agricultural research site in Faulk County operated by the Agricultural Experiment Station at SDSU (see article on facing page). Right now he has almost completed the first year of a 2-year graduate study program in which he is concentrating on research involving the use of commercial fertilizers to boost the production of grasslands. Grasslands are such an important segment of South Dakota agriculture — from size alone — that even comparatively minor improvements could have a sizable impact.

450 Plots Used

Although Greg is accustomed to farm life, last summer he got his first experience in doing research in the field — often an exacting task — as he began his studies aimed at a Master's degree in agronomy. This was no small job since he had something like 450 plots, each about 14 x 21 feet in size, which had to be precisely situated and identified for the various types, rates and times of fertilizer application for each of seven grasses or grass-legume combinations. Last summer he ended up with about 750 samples, counting some duplicates.

Even before Greg had the early plot-work fairly well in hand, he realized that harvesting the plots would also be a formidable task. Ordinarily, plot harvesting is done by hand (tedious and time-consuming) or with a cutterbar arrangement on a small tractor, somewhat easier and faster but often less than satisfactory, especially when the experimental crop of grass is short.

Builds Plot Harvester

While the SDSU student wasn't afraid of work, he figured there must be a better, and perhaps faster, way of harvesting the plots. He started with a commercial flail-type harvesting implement designed for mounting on the front of a small, lawn-type tractor. He reversed the flailworks, added a looped section of sheet steel to the pick-up section, and attached a "rabbit cage" collecting box to the front to catch the harvest.

It worked.

"Originally I had in mind something that would do the job faster as well as pick up the complete sample with one pass of the little tractor," Greg explains. "Actually, it doesn't do the work much faster but it does pick up the shorter grasses which couldn't be reached with a cutter bar. Only changes I plan before next summer are to make the collecting box bigger and change the angle of the opening so we can pull out the samples easier."

Others also thought the budding agronomist had more than a homemade gimmick. The company that manufactured the flail was interested in knowing what had been changed and how it worked. Several research organizations have also shown interest in the implement.

When he's not working with his plots at the Pasture Research Center in summer Greg is busy on the SDSU campus as a graduate student carrying 11 credit hours and as a half-time graduate assistant with a teaching assignment of 9 hours weekly in a soils course. Between studying and preparing for teaching his classes he serves as one of six members of the South Dakota Youth Advisory Committee for the Selective Service System, a group selected from nominations by heads of various schools and organizations to represent a cross section of the youth in the state. Greg represents agriculture and is responsible for contacts with youth in high school, college and those working on farms.

Options for Future

When Greg finishes at Norbeck and at SDSU possibly in the spring of 1971, he isn't sure what will be next. "It might be additional studies, perhaps teaching or more research," he says. "I might also have a military obligation to get out of the way." He was commissioned a 2nd Lieutenant, Infantry, in 1969 upon completion of Reserve Officers Training Corps studies at SDSU.

He is the son of Mr. and Mrs. Ervin Grenz who farm northwest of Eureka. Mr. and Mrs. Grenz also have a daughter, Josephine Ann ("Joey"), at SDSU. She is a sophomore in physical therapy. Greg's little sister, Michelle, 7, is a second grader at Eureka.

Greg's work at Norbeck is a good illustration of how research and classroom studies are combined at SDSU to widen the experience of the student as well as secure a return for South Dakota agriculture. His contribution forms a small — but important — continuing part of the overall grasslands-fertilizer research effort which is directed and conducted by regular SDSU staff members. He is guided and supervised by Agricultural Experiment Station agronomists Raymond C. Ward, Paul L. Carson, and Raymond A. Moore and Edward J. Williamson of the Extension staff. Hundreds of graduate students have done much the same in the past and hundreds more will be given the opportunity in the future.

A gram scale is used to weigh a portion of the plot sample at cutting time. Later in the laboratory this same sample will be dried to zero moisture, the difference in the cutting-time weight and dried weight gives moisture content of the grass. Protein content — an indicator of quality — is another of several additional analyses made in the laboratory after the summer work is finished.

Multiple buds and thicker-than-normal stem on a flax plant that was treated with kinetin. This section, with leaves removed, is from the upper part of a flax plant.

Flax Growth Regulators

By
David J. Holden, Professor, Botany-Biology Department

Flax plants that stay "young" longer and withstand hot weather better are sought to help boost flax seed yields.

Two approaches — both with growth regulators — used at South Dakota State University include breaking lateral bud dormancy and extending the growing period.

Both can be done with TIBA under controlled laboratory conditions. TIBA is sprayed at 100-300 p.p.m. just after full bloom but plants must have proper care and cool temperatures until harvest time.

The spray almost completely breaks lateral bud dormancy resulting in a "rejuvenated" and longer-living bushy plant with capsules along the stem becoming a "second crop." Thus, surface area exposed to photosynthesis is increased as well as length of time photosynthesis can occur. In turn, the effect is more carbohydrate, more plant growth and theoretically an increase in yields.

In the Upper Midwest flax growing region the crop usually matures in mid-July. In most field experiments where flax is sprayed with TIBA at this time of usually warm, dry weather the lower lateral branches fail to develop and yield is not increased.

As we cannot provide cool weather in the field, we are experimenting with additional growth regulators that prevent senescence (aging) and help the plant withstand stress of hot late-July or August weather. These new regulators used alone and in combination with TIBA show promise.

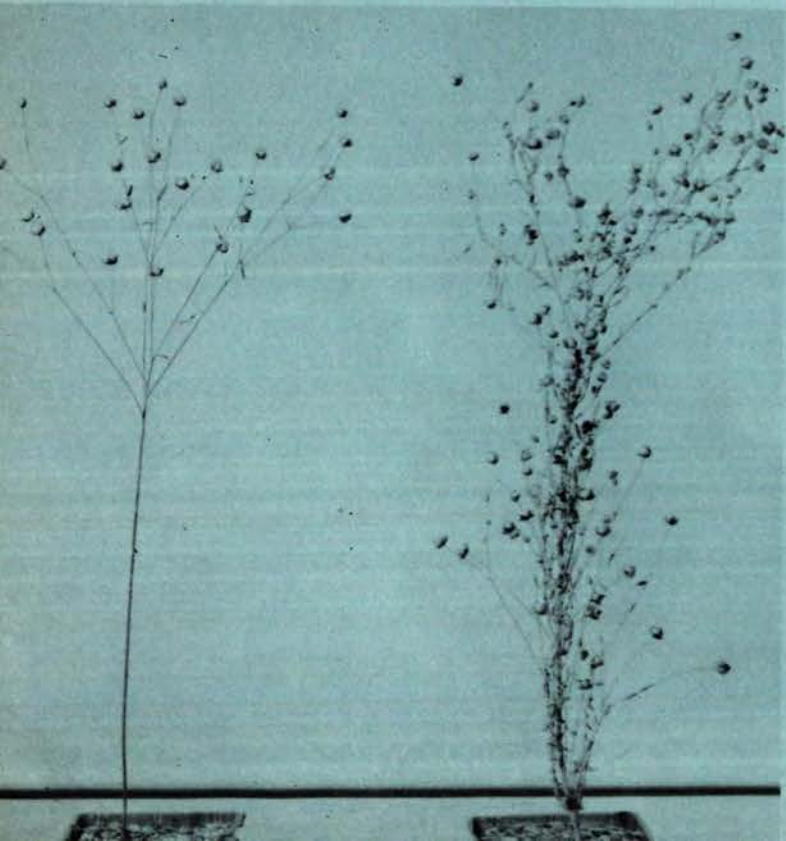
One of these substances, kinetin (or related substances), causes an unusual response in flax. Kinetin, a plant regulator, is noted for its ability to delay or prevent senescence or aging in fruits and vegetables — in fact is used in some countries to increase storage life of these products during shipping and sale. At least one mode of action is that it prevents chlorophyll destruction. Its application on flax produces a similar response. In addition, it promotes callus formation and the formation of multiple buds where only one would ordinarily appear. Therefore if proper application is achieved, kinetin can act somewhat like a juvenile hormone. The combination of kinetin and TIBA may offer possibilities for controlling the life cycle of flax.

Experiments show boll increases from an average of 12.3 per plant to 34.5 per plant with TIBA treatments. Regulators have increased seed production by as much as 62% over untreated controls in growth chamber experiments.

If successful and practical on a field basis these experiments will lead to more complete control of growth of the flax plant and a possibility of maximum yield potential of around 40 bushels an acre, about twice the usual yield.

Currently we do not recommend TIBA for field application on flax. If you add too much at the wrong time the resulting abnormal plants decrease yield. Even if you spray the right amount at the right time you'll not boost yields much unless a period of cool wet weather happens to follow the application. In at least one instance these conditions were favorable in the cool northern flax region of Canada where a grower obtained a yield increase by spraying an early variety of flax.

The bushy flax plant (right) resulted from spraying with a growth regulator which broke lateral bud dormancy. Capsules normally develop only on the top of the plant (as in unsprayed plant at left) while the ones along the stem are the "second crop" as a result of TIBA application.



New Varieties of Small Grain

Spraying for control of leaf diseases in experimental plots using a knapsack sprayer adapted to spray a 3- to 4-foot area. This is an F_1, F_2 yield test.

New varieties are tested every year by the Agricultural Experiment Station at several places in South Dakota and the results made available to the public. Sources of new varieties are the land-grant universities and private breeders. Results of the tests can help the producer decide whether or not to replace the common varieties he is now using with the new releases.

Spring Wheat

Neepawa was developed by the Research Station of the Canadian Department of Agriculture at Winnipeg, Manitoba. It is awnless, white chaffed, a day earlier than Chris, the same height as Chris but with stronger straw. It has been more susceptible to leaf rust than Chris and like Chris it showed a small amount of stem rust at some locations in 1969. Neepawa is similar to Chris in yield and test weight.

World Seeds 1812 is a semi-dwarf spring bread wheat released in October, 1969 by a private breeder. It is 9-12 inches shorter in height than Polk and Chris and has stronger straw. It is 4 days earlier than Chris in heading. Yields measured across five stations in South Dakota in 1969, the only year tested, showed 32 bushels for Manitou and Chris and 28 bushels for World Seeds 1812 when seeded on summer fallow to which adequate amounts of fertilizer had been applied where needed. It averaged 2 pounds lower in test weight than Chris and Manitou. World Seeds 1812 may have more resistance to stem rust than Chris or Manitou and like them is resistant to leaf rust. In rates of seeding tests of Chris and World Seeds 1812, at Highmore, Redfield, and Brookings, using 30, 60, and 90 pounds of seed per acre the lower rates were generally superior to the 90 pound rate in yield. Protein level in whole seed of World Seeds 1812 was about 1% lower than for Chris at the Highmore test site. Lower protein is an important fault of World Seeds 1812, reducing its value in the market both for domestic use and for export. While this variety is agronomically better than Chris and Manitou for reasons given above, it should be grown only with the awareness of its faults as well as its virtues.

By

D.G. Wells, professor of plant science; J.J. Bonnemann, assistant agronomist; G.W. Buchenau, associate professor of plant science; W.D. Stegmeier, assistant in plant science; and C.L. Lay, formerly assistant in plant science.

Bonanza is a semi-dwarf spring bread wheat. Seed was not made available to the Agricultural Experiment Station so Bonanza has not been tested. One commercial research organization has reported testing Bonanza at one location in South Dakota, near Aberdeen.

Hercules durum wheat was developed by the Canadian Department of Agriculture at Winnipeg, Manitoba. It is 3 to 4 days earlier in heading than Leeds and Wells and is of similar height. It resists both leaf and stem rust unlike Wells which has begun taking some stem rust. The seeds of Hercules are larger than those of present varieties, a trait liked by manufacturers of pasta products. However, the color of spaghetti or semolina made from Hercules is less desirable than that from Wells and Leeds.

Barton. A bearded variety of standard height developed by a private breeder. It has been susceptible to leaf rust and resistant to stem rust in South Dakota. Barton has not been yield tested by the Agricultural Experiment Station. The North Dakota Experiment Station has indicated that this variety tends to be low in test weight and yield.

Yields (in bushels) of flax varieties 1969.

	Brookings	High-more	Water-town	Average
Norstar	24	25	19	23
B-5128	20	26	20	22
Bolley	23	23	14	20
Linott	25	28	21	25
Nored	28	23	22	24
Summit	29	26	23	26
Windom	24	28	19	24
Foster	26	28	23	26

Kurtzman. Developed by a private breeder, this bearded, semi-dwarf is susceptible to leaf rust and to some prevalent races of stem rust. Like Barton, Kurtzman has not been in Agricultural Experiment Station yield tests. The North Dakota Experiment Station has faulted Kurtzman for its very low test weight and low yield.

Flax

Norstar is a blue flowered medium maturing flax variety developed by the Minnesota AES and USDA and released jointly with the South Dakota and North Dakota AES in 1969. It is similar to Summit and Windom in height but of later maturity. Oil content and quality are lower than for Bolley and Nored. Norstar is resistant to rust and wilt and moderately susceptible to pasmo and thus resembles Summit and Bolley in reaction to diseases. It is of medium yielding ability.

Rye

Cougar was developed by the Department of Plant Science, University of Manitoba, Winnipeg, Manitoba. It was selected from a composite of 19 varieties. It is similar in winterhardiness to Antelope and Frontier. Cougar has shorter and stronger straw than Antelope, Caribou, and Frontier. It was the top yielder in 1969 tests in South Dakota which are not reported here because stands of some varieties were poor.

Pearl was released by the Agricultural Experimental Farm, Swift Current, Saskatchewan, Canada. Stands were low in 1969 South Dakota tests because of poor seed so no estimate is available of Pearl yielding ability.

Yields (in bushels per acre) of some varieties of spring wheat in South Dakota, 1969.

	Bison	Wall	Eureka	Water-town	High-more	Brook-ings	Aver-age*	% of Chris	% ad-vantage of Chris, Manitou
Chris	25	23	39	32	37	26	32	100	0
Manitou	25	24	39	34	37	25	32	100	0
Sheridan	24	22	37	32	40	23	31	97	3
Polk	20	27	38	30	34	23	29	91	10
Red River 68	18	22	34	23	31	15	24	75	33
World Seeds 1812	23	----	32	30	34	22	28	88	14
Neepawa	25	23	39	29	37	20	30	94	7
Hercules durum	23	26	41	30	39	24	31		
Wells durum	26	32	46	30	46	25	34		
Leeds durum	28	32	43	25	43	22	32		

*excluding wall

Test weights of some varieties of spring wheat in South Dakota, 1969

								Watertown			Brookings
	Bison	Wall	Eureka	Water-town	High-more	Brook-ings	Ave.	Ht. in.	% Lodg-ing	Stem rust	Date ½ headed
Chris	56	58	60	59	57	56	58	39	23	MS	7/2
Manitou	54	59	60	61	59	56	58	41	23	R	7/1
Sheridan	54	59	61	60	60	55	58	43	45	R	7/3
Polk	56	61	61	60	60	57	59	39	10	R	7/2
Red River	51	59	58	57	56	52	55	33	5	R	6/28
World Seeds 1812	50	----	60	58	59	54	56	27	3	R	6/28
Neepawa	52	57	60	60	58	55	57	39	5	MS	7/1
Hercules durum	55	61	61	59	59	55	58	39	3	R	6/30
Wells durum	56	63	62	57	60	57	59	39	10	MS	7/4
Leeds durum	59	63	63	60	62	55	60	40	2	R	7/3

R=resistant; MS=moderately susceptible.

Spring seeded triticales, a type of hybrid between wheat and rye, at Presho. Included are winter, semi-winter and spring types.

Forecasting Profits from Spraying for Wheat Rusts

If you decide to spray for rust control, contact your county Extension agent for details about recommended chemicals and procedures.

By
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Wheat farmers faced with leaf or stem rust problems may be interested in an experimental do-it-yourself method under development for predicting whether or not chemical spray controls will be profitable in a given season.

The problem is that rust development varies greatly from season to season. In some seasons, for example, 1965 and 1968 when rusts were quite prevalent, money invested in rust control yielded returns up to 128% compared with a 5% return if the same money had been invested in a bank. In other seasons, including 1969, the farmer would have lost money because rust damage was comparatively light and controls didn't pay off their costs through increased yields.

Since control sprays must be applied before rust damage becomes heavy, the farmer has to gamble almost sight-unseen on whether or not "this is the year" to spray. In other words, it is like betting on a horse race without being able to get a look at the tote board.

Agricultural Experiment Station plant pathologists at South Dakota State University believe they have a method that might help the farmer "take a peek into the future" and act accordingly. The method, although still under development, is considered much superior to the "complete guess" way of dealing with rust problems. It is derived from experiments with rust sprays in plots at several South Dakota locations over the past 8 years.

Three separate but inter-related calculations are involved: (1) predicting rust development, (2) predicting yield loss, and (3) estimating profits from spraying. All three calculations are made from a chart as in Figure 1 which is included to provide you with a handy worksheet. It is done in late May or early June. (Fig. 1 on page 34).

This research was sponsored jointly by the South Dakota Wheat Commission and the Agricultural Experiment Station.

CALCULATING LEAF RUST

Forecasting Rust Development --

STEP A. Sample your field and determine the number of rust pustles per leaf or stem. Sample the 3rd leaf from the top (the 1st leaf is the flag leaf) in late May or early June when 2 nodes are visible at the base of the stem. The flag leaf is usually out at this time but the boot is not yet swollen. This is about 10 days before heading. A single node is visible about 20 days before heading.

Collect 100 leaves (3rd leaves) from several parts of the field and count the total number of rust pustules on these 100 leaves. Then determine average number of rust pustules per leaf. For example, a total of 10 pustules on 100 leaves= 1/10 or 0.1 pustule per leaf; 30 pustules=0.3; 150 pustules=1.5.

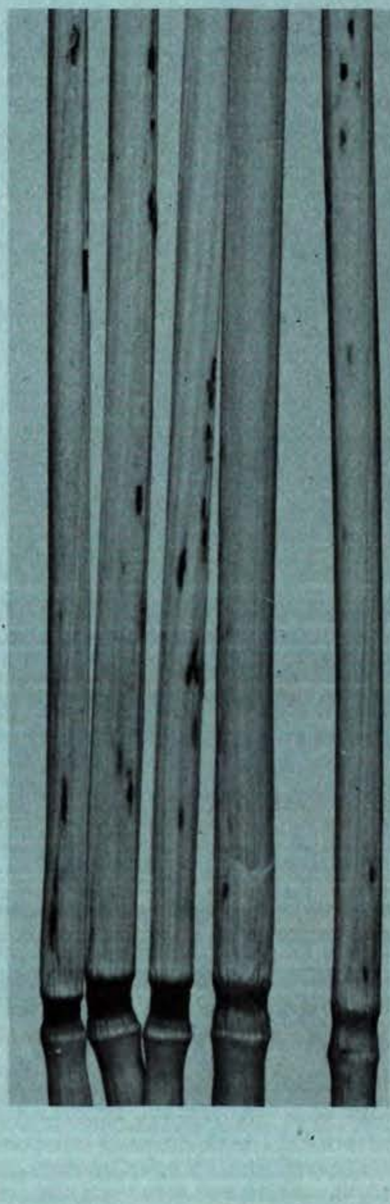
STEP B. Plot the average number of pustules, as determined above, as a point on Figure 1, Worksheet. Be sure it is located at the proper time (see "a" on Figure 2, Example Worksheet).

STEP C. The point in Step B represents rust on the 3rd leaf. We want to predict rust on the 2nd and flag leaves. To do this we add a correction of 6 days (to take care of a "lag" in rust development) by moving our point 6 days to the right (horizontally) on the chart to point "b."

STEP D. Now we decide how fast we think rust will develop:

*If the past week has been dry with no dew, a slow rust increase is indicated (41-degree angle as plotted on the sample worksheet).

Spots appearing black on these wheat stems are rust pustules.



*If the past week has been wet with heavy dew, a fast rust increase is indicated (71-degree angle as plotted on the sample worksheet).

For a fast rust increase condition use a protractor, or the "template protractor" clipped from one of the figures, and measure an angle of 71 degrees from the corrected point (at "b"). Extend a line ("c") from "b" through the 71-degree angle mark to the top of Yield Square. This is the rust slope.

For a slow rust increase similarly draw a line with a 41-degree angle as at "e."

For a moderate rust increase line which will provide us with a means of taking into account weather modifications over the next few weeks, apply a moderate slope angle (59 degrees) in addition to the fast or slow slope that you have chosen. The main reason for the moderate slope is to give you an idea of rust losses possible should weather change.

Estimating Yield Loss --

STEP E. Yield loss is estimated by determining what percentage ("d") of the total Yield Square lies under (or to the right of) the rust slope. You can do this by counting the smaller squares in the Yield Square to give a percentage figure.

STEP F. Take the yield you estimate your field should produce normally and multiply by the estimated loss from leaf rust (in percent). This will give you the rust loss in bushels.

Estimating Profit from Spraying --

Currently available rust control chemicals have two limitations: (1) a lag period of about 7 days before any effect on rust development can be detected, or in other words rust will continue to develop for another 7 days after spray is applied; and (2) the chemicals are not 100% effective -- you can expect to control about two-thirds of the rust spread. If a fast rate of rust increase is anticipated, you can expect the chemical to reduce this to a slow rate.

STEP G. We must allow for the 7-day spray "lag." To do this, select the day on which you plan to spray ("f") and count off 7 days to the right of this point ("g"). From here, go up vertically until you intercept the rust slope ("h"). This is where the rust level will be by the time the spray becomes effective. At this point on the rust slope use a protractor, or the clipped "template protractor," to measure a 41-degree angle (slow rust increase) and extend a line as you did for a 71-degree angle under Step D. Read the answer by counting the number of squares under the new slope "i." This is the loss in percent you can expect from rust, even if you do spray. Subtracting the loss that will occur even if you spray from loss that will occur if you do not spray provides an estimate of the gross profit to be made from spraying. (See Figures 2 and 3 for worked examples).

CALCULATING STEM RUST

Some leaf rust loss occurs nearly every year in South Dakota, but losses from stem rust vary greatly. In calculating losses they are determined separately, then added together. Pustules or lesions of stem rust are easily distinguished from leaf rust by their larger size and brick-red color.

The procedure for calculating stem rust is identical to that for leaf rust with the following exceptions:

(1) The time span extends from heading (0 days) to 40 days (40) so you use the bottom baseline scale of the chart (Step B).

(2) You sample 100 stems instead of leaves and plot the average number of pustules per stem directly on the chart at sampling time (Step B). (You do not move the point to the right for flag and 2nd leaves as you did under Step C for leaf rust).

Timing Spray Applications --

Two or three applications 10 days apart normally are recommended for rust control. By using the above methods considerable information can be obtained regarding number and frequency of sprays. For example, intensive control over a short period of time may sometimes be better than over a long period. In such cases you might obtain better results by reducing the interval between sprays to 7 days rather than 10. Total costs of rust control using aircraft will normally run about $2.60 per acre per application, but varies somewhat depending on the chemical used and the application charge.

WORKED EXAMPLES

(Figure 2 -- Rust forecasting and spray prediction).

Situation: It is the first of June and you are standing in your wheat field which shows lush growth, good moisture and fertility. You're thinking about a potential 50-60 bushel an acre yield. The plants have 2 nodes showing at the base of the stems and the flag leaf is partially out. A count has shown that the 3rd leaves of these stems average 0.2 pustules of leaf rust per leaf. The variety is reported as being resistant to stem rust and you have not found any, but you will check this frequently just to be sure.

Questions: *Will it pay to spray for rust if I spray today?

*What if I wait for 2 weeks before I start spraying? (See Figure 3).

Method: Plot 0.2 pustules-per-leaf at -10 days ("a" in Figure 2). Move point 6 days to right to estimate rust on flag leaf ("b"). Since the past week has been wet with heavy dew, anticipate a fast rate of rust increase -- project a 71-degree angle ("c") from the corrected point "b." A fast slope will result in a 35% to 38% loss, as determined by counting the small squares "d."

If I spray today, the spray will become effective in about 7 days (which in this case is about the same as our corrected point "b") and the spray will reduce rust increase to a slow rate. Hence, project a 41-degree angle ("e") from corrected point "b." This line does not intercept the yield square, so we should be able to prevent all of the loss from leaf rust by spraying at this time (10 days before heading).

If we do not spray for rust, we can expect to lose 38% ("d") of our estimated 50-bushel crop or 19 bushels an acre. If wheat sells at $1.35 a bushel, then we have a potential loss of about $25 an acre.

Note that rust must be controlled for the full 40-day period. We could theoretically make 9 applications and still break even, but this is not necessary. One might choose instead to spray at 7-day intervals for 3 applications, keeping an eye on the weather between sprays. (In wet weather, reduce the time between applications).

By applying three sprays, at a total cost of about $8.00 an acre, one should be able to save nearly all of the $25.00 loss, making a profit of $17.00 an acre.

(Figure 3 -- Waiting 2 weeks before starting to spray).

Method: In Figure 2 it was established that leaf rust will cause a loss of 38% or $25.00 an acre on our 50-bushel per acre potential yield.

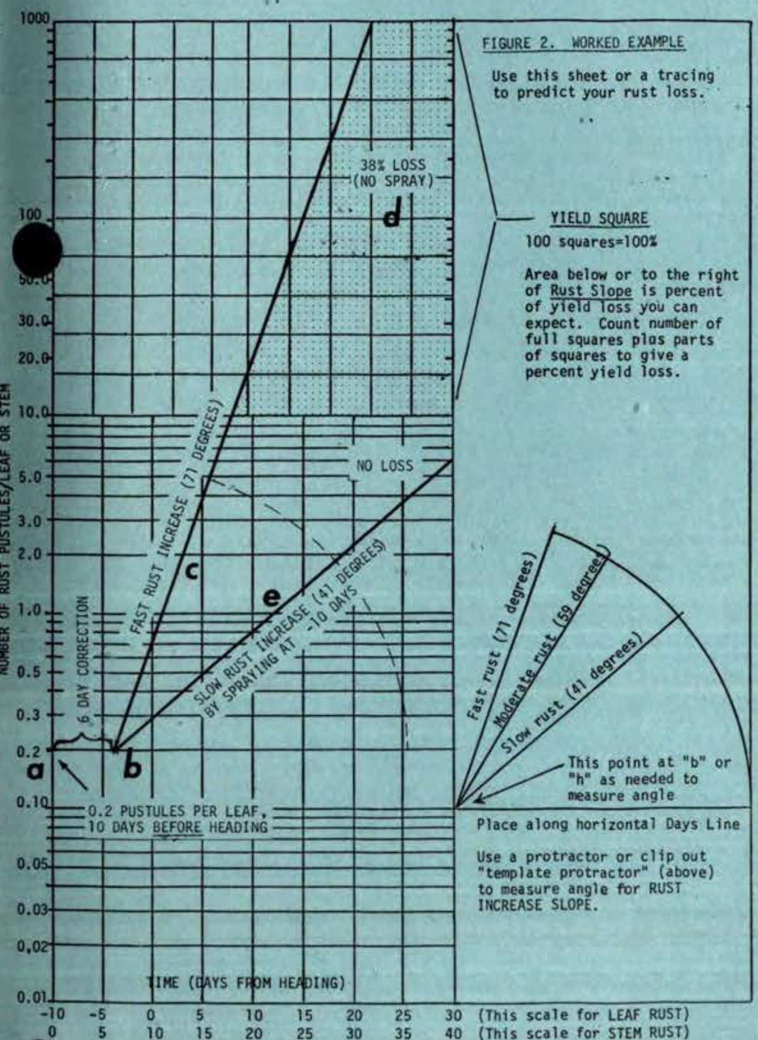
Two weeks from the initial sampling date of -10 (10 days before heading) will be 4 days after heading. By that time rust will have reached a level of about 3 pustules per leaf on the flag leaf. (Simply go up vertically from 4 days until you hit the rust slope at "f").

If we spray at this point ("f" or 4 days after heading), it will be 7 days before the spray becomes effective "g." By this time (determined by going up vertically from "g" to meet the rust slope at "h"), rust will have reached a level of 30 pustules per leaf. The rust slope is affected by the spray and now at 11 days after heading we can draw a line with a 41-degree slow rust slope at "h." In other words, at a point 7 days after you plan to spray, go up vertically to intercept the rust slope and draw a slow slope from there.

The area "i" under the 41-degree slope can be determined to be 21% by counting the small squares. This 21% represents the loss that will occur even if we spray. This represents about 10 bushels an acre or $13.50 an acre loss even if we spray. We have gained $11.50 an acre gross profit by spraying 4 days after heading.

Since 2 sprays will be needed to protect the wheat for this 26-day period (from 4 days to 30 days after heading) expenses will total about $5.20 an acre and your profit should be $11.50-$5.20=$6.30 an acre from spraying.

A further extension of this problem will show that delaying the first application until 10 days after heading will result in practically no reduction of leaf rust loss.



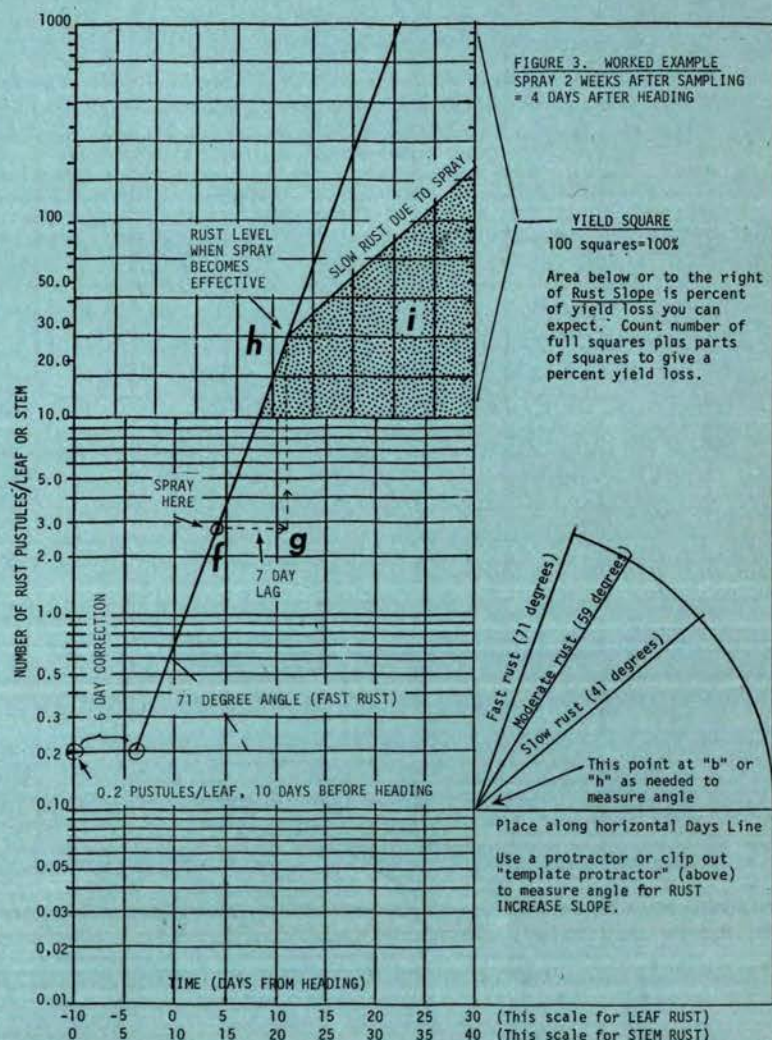


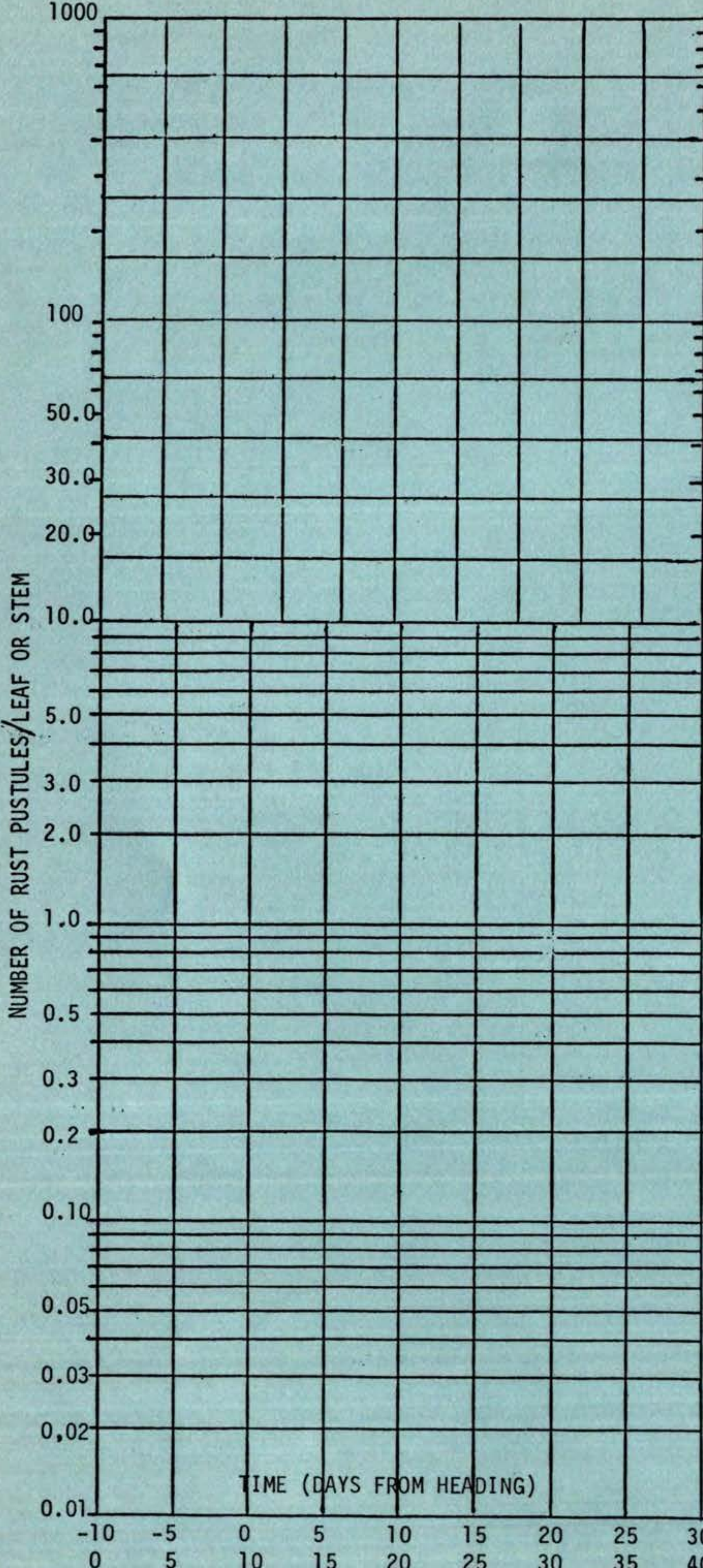
Figure 1. YOUR WORKSHEET

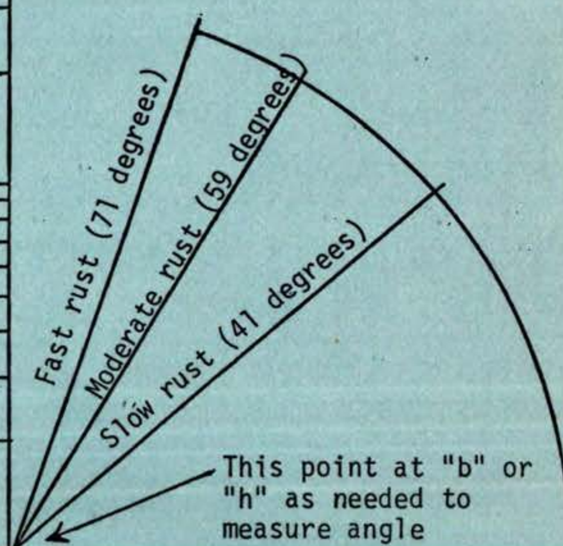
Use this sheet or a tracing to predict your rust loss.

YIELD SQUARE

100 squares=100%

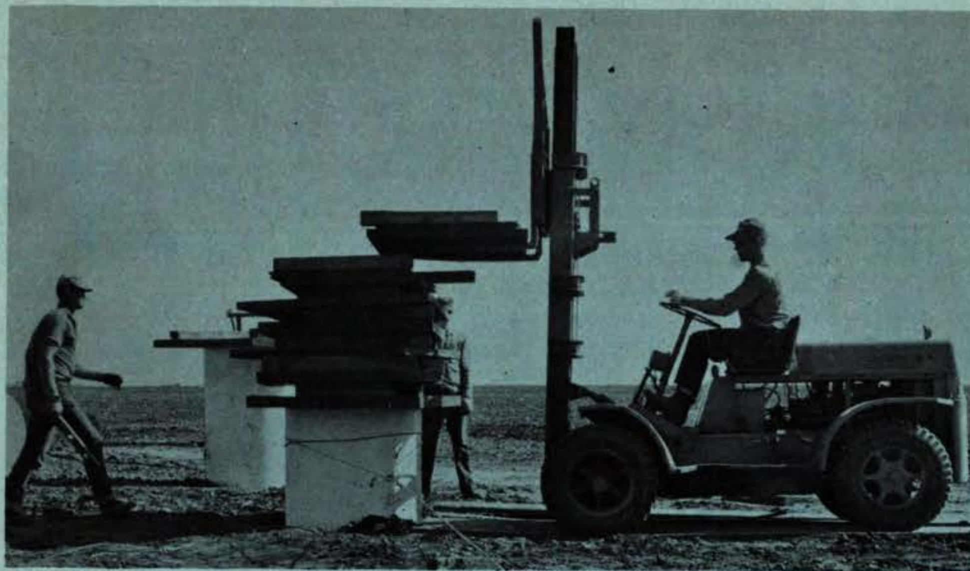
Area below or to the right of Rust Slope is percent of yield loss you can expect. Count number of full squares plus parts of squares to give a percent yield loss.

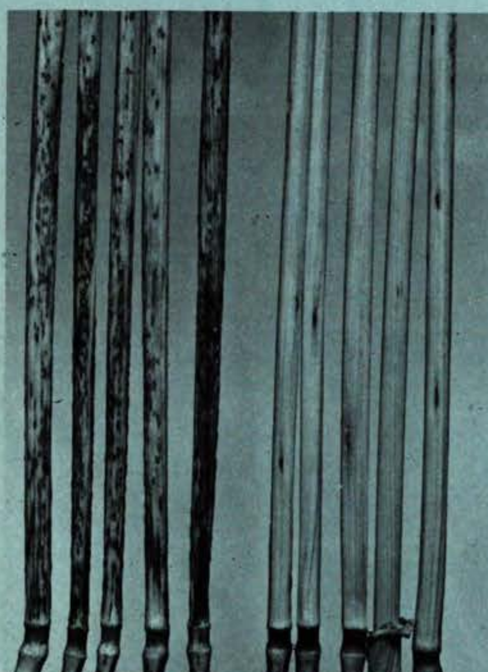




Place along horizontal Days Line

Use a protractor or clip out "template protractor" (above) to measure angle for RUST INCREASE SLOPE.





Would you believe that 3-inch armorplate is used in some agricultural research (above)? Read how it was done in an article about irrigation research beginning on page 4.

You'd need a functioning crystal ball to keep ahead of the wheat rust problem (left). SDSU plant pathologists believe they can help with a do-it-yourself method of calculating rust damage, described starting on page 31.

What's in the picture for fertilizing South Dakota grasslands (below, left)? What has and is being done is reflected in articles on pages 26 and 27.

BB

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